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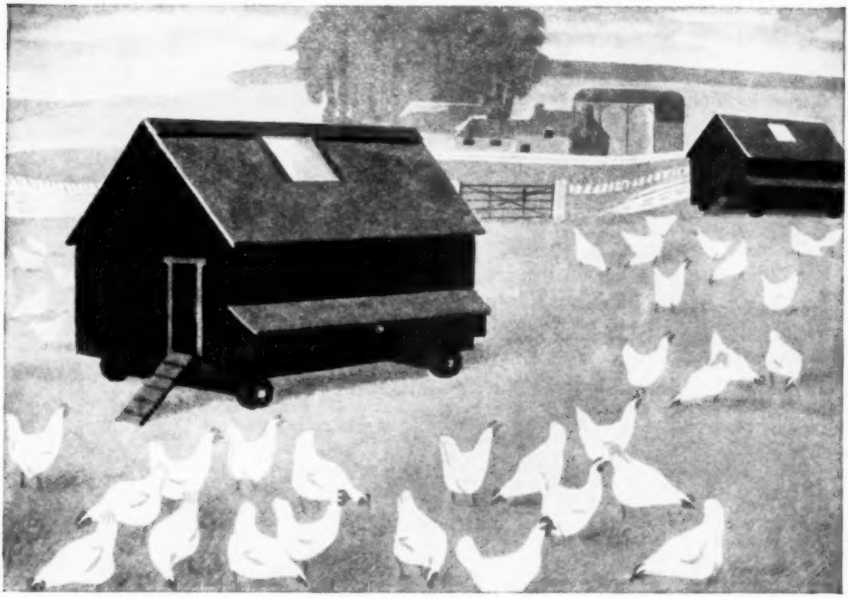

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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VOL. LVI No. 5 AUGUST 1949

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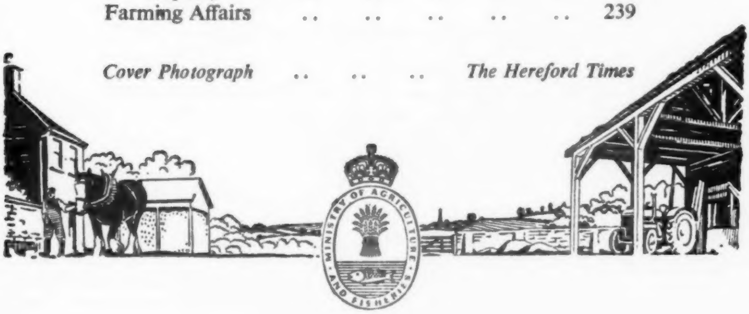

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MORE CORN

THERE is, as is well known, deep anxiety about our present economic position and still more about what may happen to us in three years' time when Marshall Aid comes to an end. Despite the large measure of help that we have got and are getting from the United States and Canada, our small reserves of gold and dollars have lately been slipping away at an alarming rate. In other words, so far as dollars are concerned, we are living beyond our means.

Various things have already been done to reduce the drain on our bank balance, including a substantial cut in imports of raw materials and other things from dollar countries, but these do not alter the fact that we are faced with a clear choice ; either we must, by one means or another, achieve a substantial increase both in our industrial exports and in our home production of food before 1952, or we must then reconcile ourselves to a substantial fall in our whole standard of living.

The part that our own farming industry was called to play in national recovery was set out, two years ago, in the Agricultural Expansion Programme. We were to increase our output of food until, by 1952, it should be half as much again as it was in the pre-war years, and thereafter it was to be kept at this new level. This was, admittedly, an ambitious plan ; but the organizations of farmers and workers alike agreed that it was within their powers to carry it out.

Part of the increased production was to be achieved by better all-round farming—by raising our average yields of wheat, potatoes and other crops and by getting more milk per cow, more eggs per hen, and so forth. But it was necessary to seek further ways of getting still more of those things which, if we do not produce them ourselves, must either be bought for dollars or not bought at all. The chief of these are meat, fresh meat, and bacon.

In surveying the possibilities of higher production it seemed to the Ministry that the greatest opportunity was offered by our grasslands—by ploughing out and reseeding in the hills and other marginal areas and by changing over elsewhere to ley farming wherever arable crops could be grown successfully. It seemed too that our grassland, through the development of ensilage and grass drying, could contribute substantially more, especially in protein, to the winter feeding of our livestock. These things are coming to pass. We have much upland pasture and rough grazing that could be converted into something far better, and we have still a deal of poor old grass on land that could be farmed, with much higher production, on the ley system. But good progress is being made.

It was, however, obvious from the outset that if grassland development went according to plan and if the old acreage were maintained, we should soon have more grass than we could stock. The calf subsidy was introduced in order to encourage the rearing of all calves that had the makings of useful beef, and it has largely succeeded in its object. But even so, the increase in

cattle herds must, in the nature of things, be slow ; it cannot conceivably keep pace with the rate of grassland improvement that is possible and that is needed. It is unlikely that the increased supply of Irish stores will fill the gap. In theory, sheep numbers can be built up much faster, and in a few counties expansion is now rapid. Elsewhere, however, serious difficulties stand in the way—especially the lack of fencing for grass flocks and the scarcity of skilled shepherds. We can still increase the breeding and rearing of meat animals but the indications are that the supply of grazing stock will not be enough fully to stock next year's grass, assuming an average season ; and understocking is the surest and quickest way to undo our own efforts to maintain highly productive swards. Moreover, in a reserve of silage we have a good insurance against summer drought.

In short, the object of the grassland development programme is to enable us to keep more stock, and do them better, *on fewer acres*.

What then shall we do with the land that can thus be spared ? In the wet uplands of the west, where only a small acreage of corn can be saved with the amount of good harvest weather that is to be expected, rape can be grown to fatten lambs and flush ewes, and more kale can be grown to supplement silage and hay. In these areas one of the chief needs is to secure a better balance between winter and summer keep, and particularly to carry the young stock round to the spring in healthy thriving condition. In other areas, the spare land should be used, in the main, to grow more corn.

It is here that we are failing to implement the expansion programme. This year's wheat acreage will be little more than two million acres, whereas our target was 2,500,000. The short-fall is thus about 20 per cent. Last autumn was, of course, a difficult time, with a dragged-out grain harvest and a full acreage of sugar beet and a record acreage (and tonnage) of potatoes to lift. Reduced autumn sowings were to be expected, but it was hoped that a considerable part of the short-fall would be made good by extra spring plantings for which a dry and mild February gave every opportunity. But this did not happen. It seems that many farmers still look upon spring wheat as an unreliable and, on average, an unprofitable crop—as indeed it used to be. But there is plenty of evidence, especially from the Midlands and West, that the newer spring varieties will, taking one year with another, yield just as well as the winter sorts.

Even with an overall deficiency in wheat, the loss could have been largely made good by bigger sowings of barley and oats. But these did not materialize. Indeed, the area sown with these grains fell short, by 150,000 acres, of the target.

The importance of maximum wheat production is obvious ; the dollar countries are the only source from which we can make good any deficiency. The importance of coarse grains is less obvious because we may, under certain circumstances, and in some seasons, be able to buy, at a price, very considerable quantities without spending dollars. We were fortunate in being able to do so last year, and we have been fortunate again in making contracts to cover our requirements, our present ration scales, for the coming year. But we should be foolish if we continued to expand our pig and poultry production on the assumption that we can get equal or greater supplies in the future. Our sources are too unreliable. We must, from next year onwards, produce more of the necessary grain from our own soil. It has already been announced that the standard of self-sufficiency for dairy cows for rationing purposes will have to be raised from October 1, 1950. On most farms this can best be achieved by increased usage of silage or dried grass, of which larger quantities are being made each year. We must, however, also strive to carry the increasing numbers of pigs and poultry as well as cattle.

It would be futile to deny that there are real and substantial difficulties in raising our tillage acreage and particularly that of corn. In those counties where there was wholesale grassing down from the eighteen eighties till the 'thirties (and where we must look for much of the extra tillage), farmers will find it difficult—even with full mechanization—to get together a sufficient force of skilled regular labour. The combine is indeed solving the problem of labour for harvest and threshing, but is creating a problem of drying and storage. But the other doubts and fears that are expressed are less well founded, and some are based on misunderstanding. One such misunderstanding is that the expansion programme is billed to come to an end in 1953, and that the tillage acreage may then begin to decline. If this were so it would indeed be unreasonable to expect landowners to erect new buildings or to ask farmers to equip themselves to handle a higher acreage of tillage. But so far as it is possible to foresee the future, a high intensity of production will have to be maintained for very many years to come. The food outlook for the world at large is such that we cannot reasonably expect a return to the conditions that prevailed in the 'thirties, when other countries were pressing their food surpluses upon our market. The expansion programme is only a stage in a long-term effort towards greater self-sufficiency.

Farmers have expressed anxiety about the high incidence of soil-borne diseases of wheat—Take-all and Eyespot—both last year and this. There is no doubt that in certain districts losses have been severe. But it is by no means certain that there has been a progressive build-up of these troubles or that they would have been less severe if acreage targets had been lower. The main explanation of recent outbreaks is to be found in weather conditions ; damage is always highest after mild winters. No cure for the trouble is in sight. But serious damage is very rare, except where meat has followed wheat or barley. Such a sequence of crops, which is rarely good farming, should never be followed on land that is subject to Take-all, and is not required by the existing targets.

Again, it is sometimes argued that wheat is an exhausting crop and that the target acreage cannot be obtained without a progressive decline in soil fertility. But it is hard to convince oneself that a target acreage of 2,500,000 acres, spread out with proper regard to the nature of the soil and climate, is more than is compatible with good husbandry. Even if we make allowance for the land that has been lost to farming in the past eighty years, it is a considerably smaller acreage than our grandfathers grew ; they paid great regard to the rules of good husbandry and they had fewer resources, in the way of fertilizers, than we have today, and we have in the modern ley another means of keeping our land in good heart.

There is admittedly a good deal of light land that must be specially prepared if it is to carry a full wheat crop. On such land we must expect a high ratio of barley in the east and of oats in the west. But the produce from such crops, in so far as they are sold by the grower, will make a most valuable contribution to the feedingstuffs pool. The farmer who does not have wheat land can thus nevertheless help greatly towards the achievement of the overall increase in output.

The Minister concluded his recent broadcast appeal with the following words :

"The people of this country are looking to our farmers for a successful outcome of the task to which they have put their hand. In the national interest, and in the interests of our agricultural industry itself, we must see that the job we have to do is well-planned, well founded and well balanced. I ask you to think it over most carefully when you are preparing your cropping plans for 1950. And again ask yourself the simple question 'Am I really playing my part in this Programme : and if not, why not ?'."

FEAR OF WORLD HUNGER

Sir E. John Russell, O.B.E., D.Sc., F.R.S.

It is currently accepted that the world's population is increasing more rapidly than its power of producing food. The coloured peoples and those of Eastern Europe increase much more rapidly than those in the West. Among the Western nations, it is usually the lower income groups that multiply most quickly. The anticipated result is a progressive deterioration in quality of the populations but an increase in quantity. This part of the forecast must be left to population experts. Only the second part, that the world food production resources are nearing their limit, is dealt with here.

It is, of course, a fact that land capable of or actually producing food is lost to cultivation every year ; also that no large areas of land suitable for settlement by Europeans are now available. Nevertheless, there is still land that could be used, and much of the existing cultivation could be intensified.

Accurate figures are not known, but the world's population is about 2,000 million, and the annual increase about 20 million. The area of land having climate suitable for crop production is about 11,500 million acres—about 5 acres per head of world population. This, however, includes great tracts of almost impossible soils, while the area actually producing food is of the order of 2,000 or 3,000 million acres—about 7 per cent of the total land surface. The tillage figure is indefinite because of the wide latitude given to the term "grazing land". But accepting the data as they stand, the average allocation of cultivated land per head for the world is at present about 1 or 1½ acres per head. In Europe, about 1.5 to 1.8 acres suffice per head of population, and in the vegetarian countries of the East about half this area, or less.

It is estimated that some two-thirds of the world's population are food producers, most of them peasants, and all experience shows that the food producer is the last to go hungry when trouble comes. The food problem is therefore of unequal incidence ; it presses hardest on the crowded lands, where a large part of the population is either non-agricultural or, if on the land, redundant. The three chief regions are north-west Europe, including Great Britain and Italy, India, and east Asia, including Japan and part of China. Elsewhere the possibilities of food production are still adequate even though they may not be fully used.

Wheat Area Potential The chief food imports of north-west Europe and Italy before the war were cereals and oil seeds, but we needed meat and dairy products also. On the average, continental Europe, before the war, imported from outside its borders 11.1 million tons of grains per year, including 3.7 million tons of bread grains. But we imported no less than 9.75 million tons of grains, of which 5.6 millions were bread grains. The war upset the very efficient arrangements by which this commerce was carried on, and new ones have been set up. The grain areas of the great wheat-growing countries of Europe, France, Italy, and Spain are, or were until recently, still below their pre-war acreage, as also were those of Germany, Hungary, and Roumania. The countries of north-west Europe can no longer rely on supplies from eastern Europe. They must look to the Americas and Australia, and now compete with us. Can these countries increase their supplies to satisfy the new demands?

The reports of the Food and Agriculture Organization indicate that the world acreage of wheat, which in most countries had fallen to a minimum in 1943, had by 1946 attained its pre-war value of something over 365 million acres ; but in the meantime, of course, the world population had increased. Argentine and Australia are not yet up to their pre-war areas. Canada has a little more, and the United States still more than pre-war. This failure to

increase the world area of wheat since the 1934-38 period has been interpreted as showing that all the wheat lands of the world are occupied. But there was a similar standstill between 1909 and 1924, when the world acreage remained steady at about 280 millions ; thereafter it rose steadily until 1937, when it reached 365 millions. The block is probably due to limitations of transport and storage facilities, and until a market seems assured, i.e., until the food is needed, no one is prepared to incur the considerable cost of providing more. For the same reason there has been a similar stagnation in areas under barley, oats, and maize.

Sir William Crookes, in his Presidential address to the British Association in 1898, declared that the wheat areas of the world were almost fully exploited, and after the 1930s the world would begin to suffer hunger unless yields were increased. With true scientific insight, he indicated the way out : the synthetic production of nitrogenous fertilizers. This was duly accomplished and has led to a great increase in food production and saved us from hunger during the two wars and after. But the wheat lands were not exhausted, and indeed they have expanded greatly since his time. Canada, in 1898, had 4 million acres of wheat ; in 1940 it had 28 million ; and its present acreage is 24 million. Australia in 1898 had under 5 million, but in 1947 had 14 million acres. This quite unexpected expansion arose from the success of the plant breeders in producing new varieties of wheat better able than the old ones to grow in regions of low rainfall ; in consequence, the wheat zone was pushed more and more into the dry regions, and also into the northern regions of shorter summers. At first the plant breeders' work was purely empirical and, while much success was achieved, there were difficulties which could not be overcome, especially in regard to Rust. The development of modern genetics has greatly strengthened the plant breeders' powers of attacking problems, and after years of research the Minnesota workers, under Professor Stackman, and the Canadian Rust Research workers have now produced varieties more resistant to Rust than any before. It is quite impossible to forecast how far this wheat breeding work can go, but modern science can hardly fail to produce still more drought- and disease-resistant varieties suitable for still drier regions, and varieties that can be pushed further northwards. Crossing with *agropyron* (couch grass) is claimed by Tsitsin to do all this, and the claims are being studied in Canada.

Conservation A great difficulty about expansion into the dry regions is the liability to soil erosion : soil drifting where the rainfall is less than about 12 inches per annum, gully erosion when it is more. Undeniably, much land has been lost in this way ; in many cases, however, not beyond hope of recovery. Methods of prevention and cure are known, and the Food and Agriculture Organization reports that the importance of soil conservation is being increasingly realized, though progress is not infrequently retarded by shortage of staff and materials. In the United States and in most parts of the British Commonwealth considerable action has been taken ; to a greater or less extent forty-nine countries are doing something. The "conservation districts" of the United States, where proper preventive measures are adopted, have increased from 36 million acres in 1938 to 1,112 million acres in 1948, and by nearly 2 million acres in Puerto Rico. Active conservation plans are in operation on nearly 158 million acres, and the "treated area" is 83 million acres. Dr. Bennett, Chief of the Soil Conservation Service, in his report for 1948 writes : "By sharply increasing our present conservation operations on the land we can overcome and control erosion within twenty or thirty years." Even in the United States, however, conservation has not yet overtaken deterioration ; still less has it done so in

other countries. In any case it is a slower process, and action therefore has to be on an adequate scale.

One of the most important agents in conservation and rehabilitation is grass, which is just as valuable in the dry regions of the world as in the wet. As with wheat when it was pushed into the dry regions, so with grass; the first step is to find suitable varieties, then by selection and breeding to improve them. Since these dry regions are used more for grazing than for cropping, it is necessary to find grasses or leguminous plants suitable not only for soil conservation but also for grazing, though, of course, soil conservation comes first. Active research on this subject is in progress in the United States, Canada, Australia, New Zealand, South Africa, and elsewhere. The Soil Conservation Service of the United States recently surveyed four Western States and found only 5 per cent of the range producing its maximum output, while no more than 10 to 15 per cent was in good condition; on some 70 to 80 per cent of the range, forage production could be doubled with proper conservation practices. Similar results could be widely found elsewhere. The Australian work on range improvement has been summarized recently by Dr. Trumble in his book *Blades of Grass*; but the excellent work of Dr. Pole Evans in South Africa is not as well known as it deserves to be. He has searched the dry regions of Africa for drought-resistant grasses and found a number that are good both for grazing and soil conservation. His collection is planted near Pretoria, and it is greatly to be hoped that the necessary breeding and selection work can be carried out. Proper management of the grazing is, of course, essential.

Tropical Contribution The tropics contain large areas of land capable of producing much more food than at present, but they present special and often very difficult problems, not only technical, but human as well.

In the wet Tropics, plantation crops—tea, rubber, palm oil, etc.—grown under British or Western European supervision have given considerable knowledge of the scientific and technical problems involved, and shown the need for treating the region as a whole, i.e., putting the permanent crops on the high ground which is subject to leaching and erosion, and the annual crops, such as swamp rice, on the low ground. The proposed UNESCO survey of the forestal regions of the Amazon valley, if carried out, should show how this vast region could ultimately be utilized. The African savannah regions of seasonal rainfall are already being developed for oil seeds and other tropical crops, and this work has been helped greatly by the modern insecticides which enable noxious insects, tsetse fly and others, to be controlled. The disc plough and modern large implements have made large-scale operations possible, and though difficulties still remain, they are likely to be more on the human than on the technical side.

At the other end of the climatic scale much progress has been made in this country in utilizing high-lying land that had long been almost waste (though much of it was used in the nineteenth century), and in Sweden, Finland and Russia in extending the region of cultivation northwards and getting higher output from the podsols. It seems unlikely that all these efforts to expand the present small area of the world's cultivated land will fail.

Intensive Cultivation of Existing Land There is, however, greater scope for increased food production by intensifying cultivation of existing land. More than half the world's food producers are working on very primitive methods and obtaining very poor yields. The old medieval grain-fallow

system, discarded here in the eighteenth century, is still widely practised in the peasant countries, with other systems equally inefficient. We doubled our yields when a proper rotation was substituted and livestock husbandry fused with arable husbandry, and further, the way was opened up for greater intensification. Considerable increases could undoubtedly be obtained by similar methods in the peasant countries. There are, of course, difficulties, both technical and political ; they include the provision of a proper system of land tenure, of education, of buildings, roads, water and farming appliances ; particularly some measure of industrialization to take redundant people off the land and set them to produce the appliances the farmer needs. Before the war Czechoslovakia and Poland had both gone well on the way to do this. In India the experimental farms regularly obtain at least double the neighbouring peasants' yields. Even in our own country the most progressive farmers obtain well above the average outputs of comparable land. Once a suitable system is devised and responsive varieties of crops and stock found, the biggest advances can be expected from a fuller and better use of fertilizers. Their consumption is greatly increasing, but only a few countries as yet make adequate use of them. Finally, there are still great losses of crops and animals on the farm, and of produce between the farm and the consumer's table. Various estimates have been made of the losses involved, some little more than intelligent guesses, but others, such as the short life of a milking cow in the herd, are based on ascertained facts. The total is impressive. Fortunately great efforts are now being made to reduce these losses, and the recent addition of biochemistry to the list of sciences aiding agriculture, which has already given us selective weed-killers, tomato-setting hormones, oestrogens, anti-biotics, etc., promises still further achievements.

There is no room for complacency, but certainly none for despair ; and with intelligence and hard work the food problem for our generation can be solved. All the same the shrill sensationalism of some of the pessimistic writers will serve a useful purpose if it arouses a widespread determination to keep our own meagre allowance of agricultural land as nearly intact as possible.

GRASS SILAGE FOR SHEEP

J. Stawart
Wooler, Northumberland

AFTER two years' experience of feeding silage to sheep in replacement of roots, there is no doubt in my mind that it is a very practical proposition, provided a few simple rules are observed. The first, and possibly the most important, is that the silage must have been made from short grass, of very good quality and free from mould or sourness. A sheep is much more particular in its feeding than a bullock, and to attempt to save time or labour by careless selection and making will result only in waste of material and disappointment. Secondly, it is very desirable that the change from any other feed to grass silage should be made gradually—introducing into the sheep's feed only small quantities until the change-over is complete. For example, one may have sheep folded on rape or kale in the autumn and wish

either to feed them off on silage or carry them through the winter as stores. In either case a proportion of hay can be fed with either of the crops mentioned and so get the sheep accustomed to feeding from a hay-rack. It is then only a matter of gradually substituting silage for hay, and when the animals have reached the stage of running to the rack as soon as it is filled with silage, it can be assumed that it is safe to change over completely to silage in place of the grazing crop.

So far, all my grass silage for sheep has been made with molasses, but I don't think this is essential. The results obtained by using a small tower type of silo have been very satisfactory, partly because silage made in this way is not quite so damp as that made in a pit and partly because of the greater heat generated. The product may be less digestible but it is more palatable.

When the pit or tower silo is opened, protection from wet weather can be secured by covering the top of the silo with straw, avoiding any depression in the middle which might hold water. I have found that no surface of silage should be exposed to the air for more than three days, otherwise it will start to mould.

Feeding Practice In feeding grass silage to sheep, it is unwise to lay down any hard and fast rules as to quantities. This is a matter which depends primarily upon the relation of silage to other food available. My experiments have been made to avoid the use of root crops for the feeding and storing of sheep during the winter months and to reduce the consumption of hay and expensive protein foods. My normal practice with feeding sheep is to fold them on rape or kale from about the beginning of November until the beginning of December, when the change-over to silage is started. By the middle of December the change-over is complete and within a month selling begins. In 1947 about 160 feeding lambs went on to grass silage in December and, even though these were in good condition at the time of the change-over, weighing 124 lb. live weight, the average killing-out weight of 69 lb. at top grade gives a very satisfactory liveweight gain per week during the five weeks they were on silage. In 1948 the same procedure was followed, and this time 204 lambs were changed over from rape to grass silage on December 8. In this case the average weight of all lambs sold between the time of going on to silage and February 14, 1949, was 67 lb. (carcass weight).

It has not been my aim to dispense with concentrates entirely in the feeding of sheep, but rather to substitute grass silage for turnips and to make full use of home-grown cereals. I think that there can be some saving of high-priced protein foods by the use of a fairly high protein silage, and in my case the silage was grown largely on a very light sandy soil. The crude protein content of the 1947 silage was 15.02 per cent, with a fibre content of 32.24 per cent in the dry matter, and it is quite possible that one could obtain a better protein percentage on land with more body. However, at the moment, I feel that by using the lighter land to grow grass silage more use can be made of the grass than by grazing in the normal way.

Over a long time I have tried out different weights of silage per lamb per day, and with 1 lb. of crushed oats and ¼-½ lb. of good hay, I have found that 10-11½ lb. of silage will give a liveweight gain of 2-3 lb. per sheep per week.

As regards water requirements of sheep on grass silage, I think that when some hay and concentrates are fed water should be available, but so far as my own experience goes the quantity required is very small.

At this point it might be worth while to discuss the most suitable type of feeding container for silage, and it will be seen why stress is laid on short

grass and good quality. I have found the diamond-sparred hay-rack to be easily the most suitable, since protection from wet weather is essential ; if silage gets wet and slimy, sheep will not eat it. Sheep prefer short grass silage, and while unchopped grass may be suitable if cut and ensiled when very young, I have found that more mature grass put through a cutter-blower also makes a very suitable feed for sheep. With a sparred rack, silage made of long grass is inclined to "arch" when the silage in the lower part of the rack has been eaten, and the upper layers have to be broken up.

Waste of material is another important consideration. Here again, short grass silage has the advantage, for when the sheep pull long silage out of the rack an appreciable amount inevitably falls to the ground and it is trampled underfoot. I have tried feeding grass silage out of ordinary open turnip boxes, but here also there is waste of material and the need to protect the silage against wet weather. I used to hope that once a sheep, say a ewe hogg, had eaten silage during her first winter, it would be easy to get her to eat it off the ground when carrying her first lambs during the following winter. With calving heifers no difficulty has been found in feeding silage in this way but, as I have said before, nothing but the best and cleanest will do for sheep. Once the feed is on the ground and trampled upon, they have no further use for it.

Changed Methods to meet Changed Conditions

In conclusion, there are several points which I would like to mention, as they have a considerable bearing on the final financial returns for fat sheep. One that comes to mind immediately is the exceptionally good health of all sheep I have fed on grass silage, and with lambs at £7-£8 each, this is a most important point. Secondly, the feeding of grass silage is economical of labour. Provided sufficient hay-racks, or other suitable type of container are used, weekend feeding entails little trouble ; a tractor-trailer can be loaded on Saturday or even Friday, and then it is only a case of filling up the racks to last until Monday morning. A hay-rack holds 3½-4 cwt. of silage, and this works out at about 10-11 lb. per head for 40 lambs per day—a suitable number to allot to each rack.

There are still many knowledgeable flock-masters who have great faith in roots, along with good hay and concentrates, as being the ideal winter feed, but conditions today demand new methods, and to the man who feels that roots are too expensive a crop to feed to sheep, silage may well prove to be the feed which will enable him to make full use of that most valuable animal.

Principal Italian Agricultural Fairs, Italy, August-October, 1949

Italian Wine Exhibition
Mostra—mercato dei vini pregiati d'Italia .. .. Siene, August 8-18

National Fruit Exhibition
Mostra Nazionale Della Frutta .. Verona, first fortnight in August

Levant Fair—International Sample Fair
Fiera Del Levante—Campionaria Internazionale .. Bari, September 10-26

National Exhibition of Italian Cheeses
Mostra nazionale dei formaggi tipici italiani
Modena, September 24-October 3

Autumn Horse Fair
Fiera autunnale dei cavalli .. .. Verona, October 9-12

THE OUTWINTERING OF BEEF STORES ON GRASSLAND

G. PEARSON HUGHES, B.Sc.
Grassland Research Station, Stratford-on-Avon

IN the June, 1948, issue of this JOURNAL a method was described of conserving grass *in situ* from late summer growth and its utilization by cattle during the winter months(1). The points brought out in that article were that cocksfoot grown in drills 2 feet apart, and of a quality equal to the general run of hay in this country, could be carried into the winter period *in situ* and could be fed to cattle without unduly spoiling the herbage and without excessive poaching of the land. The cattle were given hay in addition to the foggage, and they maintained thriftiness and their body weight.

In view of the present serious scarcity of meat in this country, and the need for increasing home supplies, the further experience gained in the out-wintering of beef stores on grass rows at the Grassland Research Station during the 1948-49 winter may be of practical importance to the grazier. In addition, the winter grazing of these grass rows has implications for herbage seed production, which will be briefly considered.

There is also evidence to show that the grass-row system of winter grazing is valuable for carrying store sheep as well as cattle. The present article deals only with its uses for cattle feeding on the assumption that, if beef cattle are to make any substantial and economical contribution to home meat supplies, much research remains to be done on the production of high quality beef from grassland. This question includes fattening on the pasture during the summer months, and indoor feeding on high quality silage and dried grass during the winter. The contention of Morrison and Heaney(2) that winter feeding on silage is a possible and profitable method of fattening bullocks is supported by the experience of indoor feeding at the Grassland Research Station.

A Way of Increasing Stores The production of prime beef from grass during the growing season necessitates overwintering of stores—of, say, eighteen months to two years old. The experiment discussed below deals directly with this problem. Possibly the method adopted is applicable only under lowland conditions in the southern parts of the country, where outwintering is not too rigorous. There are, however, lessons to be learned from the system that could be helpful for increasing supplies of stores from the rearing grounds of the North and West. More intensive systems of grassland management, coupled with the breeding of suitable hardy stores, could be introduced into the marginal areas of the farmlands of these islands. In this way greater use could be made of the potentialities of lands now lying idle. Store cattle are at present not only expensive but scarce. They could be raised fairly cheaply in the rearing districts if an appropriate system of grassland management could be evolved whereby the stock would feed on grass in the summer, and grass products (hay, silage, foggage, etc.) would provide high quality feed for the winter. Gregor *et al.*(3) have indicated the value of "complementary" grazing in providing part of the diet as protein-rich young grass, when a breeding flock of ewes and lambs is under hill conditions for the main growing period of the year. These workers, however, state that during the months of January, February and March, "complementary" grazing is impracticable. We, at this Station, believe that with the adoption of a suitable method of conserving grass *in situ* "complementary" grazing may be possible under hill land conditions during the dead months of winter. Herbage so conserved would be

of the utmost value during a normal winter period. It is with such systems of grazing that our stock-depleted hill lands can once again be made to play a major part in the provision of home meat supplies. In this manner adequate numbers of store sheep and cattle could be made available to the lowland grazier.

Under the soil and climatic conditions at this Station the aim has been to conserve herbage of the very highest possible quality for winter feeding *in situ*. The 14 acres of S.143 cocksfoot rows available for feeding in the winter of 1948-49 had been grazed with cattle during the summer of 1948. From July 19 the area was closed to grazing and a complete fertilizer dressing was given at 6 cwt. per acre, and additional nitrogen was applied at 3 cwt. per acre. The rows were cultivated fairly thoroughly. The field was then rested until it was grazed by cattle in January, 1949.

Time and Area Feeding Compared In contrast to the grazing management of the 1947-48 season([1]), when free access was allowed to the cocksfoot rows at all times, two comparative systems of grazing management were adopted in the 1948-49 winter. The essence of both systems was to ration the feed available, and for this purpose full use was made of the electric fence as described for the folding of kale by Castle and Foot([4]). The equipment proved entirely satisfactory; it needed the minimum of attention and was easily moved to a fresh site as needed. The grazing area of approximately 14 acres was divided into two blocks A and B—of 6 and 8 acres respectively.

The 6 acres in Block A were grazed as one unit. The cattle were allowed to graze for six and a half hours daily from January 18 to February 12. From then until February 22 free access was allowed for the whole of the twenty-four hours. This we shall refer to as the "range" system of management.

The 8 acres in Block B were divided by electric fencing into twelve paddocks, each of two-thirds of an acre. When feeding the cattle on this area, access to a fresh plot of two-thirds of an acre was given every three or four days, according to the feed available. Rationing in this case was therefore by *area of feed available* instead of by *time*, as in Block A.

Observations were made comparing the two systems of utilization. Attention was paid to the effectiveness of utilization and the difference in intensity of poaching on the two areas. The "range" system of grazing (Block A) and that of Block B are illustrated on p. iv of the art inset.

A comprehensive system of herbage cuts was carried out in order to follow the changes in herbage quality during the period of conservation and utilization. Relevant figures are given in Table 1. Dates of the cuts made between January 18 and April 15 correspond to the dates of the changes in management. Additional cuts were taken before the cattle were brought on to the experimental area.

In the first winter of the trial under review (1947-48) hay was fed as a supplement ([1]). For the 1948-49 winter better foggage was available. Samples cut on January 18, 1949, contained 10.53 per cent crude protein, and it was considered that no supplementary feed was necessary. The winter of 1948-49 was mild and the cattle were carried in reasonable condition without any supplementary feed. Little loss of body weight or thriftiness occurred.

Table 1 shows that the feed available during the latter part of October was of fairly high quality. It gave an analysis of 25.3 per cent "burn" and total crude protein content of 14.3 per cent. After this time, a gradual deterioration of feeding quality took place. The feed offered on January 18

Table 1. Quality of Herbage Offered

DATE OF CUT	MANAGEMENT	DRY MATTER *Yield in lb. per acre*	CRUDE PROTEIN *per cent*	COMPOSITION OF HERBAGE OFFERED EXPRESSED AS PERCENTAGE		
				Leaf	Stem	"Burn"
20.10.48	Resting	Not available	14.3	62.8 (13.13)*	11.9 (4.98)	25.3 (4.62)
8.12.48	Resting	Not available	11.5	42.6 (13.95)	7.0 (3.34)	50.4 (4.88)
11.1.49	Resting	Not available	11.3	33.7 (15.72)	8.2 (9.07)	58.1 (5.94)
18.1.49	Range grazed	2,854	10.53	32.8	7.8	59.4
22.2.49	Close folded	2,589	8.46	23.5 (15.09)	6.9 (9.66)	69.6 (6.08)
29.3.49	Close folded	2,550	8.30	20.4 (15.87)	7.0 (9.79)	72.6 (6.43)

* The figures given in brackets are the crude protein percentages of the various separates.

contained 59.4 per cent "burn" when the cattle were turned in. Towards the end of the trial period, on March 29, the "burn" had risen to a peak of 72.6 per cent. The crude protein figure on January 18 was 10.53 per cent; by March 29 it had fallen to 8.30 per cent. The percentage of protein in the green leaf, 15.87, was still high even in late March. "Leaf" contributed at this latter date still 20.4 per cent of the total herbage. The trial is not directly concerned with loss of quality at this time of year, but it should be noted that in order to get the full grazing value from cocksfoot conserved *in situ*, the herbage should be fed off by late December. Grazing to the end of the year only would allow a seed crop to be taken from the rows in the following summer without serious depletion in yield ([3]). Evidence is also accumulating to the effect that a follow-on of nutritious grazing in January to March can be better obtained from rows of leafy timothy and leafy meadow fescue conserved *in situ*. With these latter grasses the herbage is less likely to deteriorate as the winter progresses. Here again, it may be possible to take seed crops in the following summer as well as to graze in winter.

Midwinter Liveweight Gain The stocking of the area in the winter of 1948-49 was done with 1¾- to 2½-year-old cross-bred Hereford steers. Seventeen cattle were turned in to the 6 acres of Block A on January 18 and were allowed "range" grazing on a restricted time basis until February 12, when they were allowed free access at all times until February 22. At this date they were folded on plots in Block B and remained there on an "area" rationing system until the completion of the trial on April 5. Relevant figures for live weight are given in Table 2, the animals being in a fasted condition at each weighing.

Table 2. Average Fasted Weights of Bullocks

Date	*lb.*
January 18	1,158
February 12	1,198
February 22	1,188
March 11	1,185
April 5	1,140

When turned in on January 18, the cattle weights ranged between 924 lb. for the lightest beast to 1,365 lb. for the heaviest. At the end of the period of grazing, on April 5, this variation was between 878 lb. for the lightest and 1,392 lb. for the heaviest. The individual weights recorded support the view that with the quality of feed available, the more forward animal is best able to maintain condition. With improvement in cultural techniques and the production of higher quality feed, both younger and older cattle should maintain body weight without loss. Table 2 shows, on average, the loss of body weight between January 18 and April 5 on a feed supplied by cocksfoot grass rows alone to be only about 18 lb. per beast, and that until the last weighing, when keep was almost used up, body weight was on the average higher than when the cattle were first turned in.

The implications of these data are interesting and of major importance to us as a nation. It will be noted that for the first period of 25 days, i.e., from January 18 to February 12 (see Table 2) the seventeen beasts gained on an average 40 lb.—a liveweight gain at midwinter of 1.6 lb. per day. Such a gain would not be despised even at the height of a normal summer.

It is important to realize that this system of winter grazing of grass rows opens up a number of possibilities. First, it provides a cheap method of feeding store cattle during the winter. The data discussed show that for a period of eleven weeks during the non-growing season an area of 14 acres maintained seventeen head of mature cattle without supplementary feed and with insignificant loss of body weight. If such a method of winter utilization could be coupled with efficient utilization at other times of the year, it would have practical possibilities. Winter utilization of grass in rows must therefore, in some way, be coupled with summer utilization. Three methods of approach are suggested: (1) taking a grass seed crop in the summer following winter grazing; (2) providing summer grazing during the dry July-August period in the low rainfall areas; or (3) combining (1) and (2) in alternate years, but providing maximum winter grazing of high quality for every year.

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BRACKEN POISONING

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BRACKEN is one of the many plants reported on occasion to cause illness or even death in grazing cattle. That it is not a very common cause of trouble is evident from the impunity with which cattle graze on bracken-infested land in most hill districts, parks and so forth. In 1948, however, in some of the West Midland counties a number of cases in which bracken appeared to have caused the death of cattle were reported. A case of particular interest, in which most of the attendant circumstances were known and recorded, occurred in Bagots Park, Abbots Bromley.

Bagots Park is a block of primeval forest land extending to about 700 acres. Before the war it carried a poor turf dotted with ancient, picturesque oaks and large sweeps of dense, tall-growing bracken. Rushes were plentiful in places but for a boulder clay the soil could not be described as wet. It was grazed by semi-wild deer and goats ; and for as far back as living memory goes, ley stock had been taken in for grazing during the summer months. Though the herbage was admittedly of low quality, the Park had a reputation as sound rearing land ; there is no record or tradition in the district of trouble in stock from bracken. Part of it was used as a bombing range by the R.A.F. during the war. By arrangement with the owner, Lord Bagot, the Park was taken over by the Staffordshire W.A.E.C. late in the war. During 1945 and the succeeding three years a total area of about 400 acres was ploughed out and reseeded on the upturned sod, the bulk of the work being done in 1945 and 1946.

Reclamation The general practice in reclaiming the bracken-infested areas was to destroy the frond by disc harrowing when it had reached its maximum growth in July, plough in September, apply 4 tons of ground limestone dust per acre before Christmas, and cultivate and sow down as soon as the land was dry enough in the following spring. The seedbed was prepared with furrow press roll and heavy disc harrows drawn in tandem. Seeds and fertilizers were sown together, half being sown in one direction and the other half diagonally across the first drilling. The fertilizer consisted of ammonium phosphate or its equivalent, at the rate of 2 cwt. per acre. The following mixtures were sown (*lb. per acre*) :

		1945		1946
Italian ryegrass		7		
Perennial ryegrass	Mixed	18	Mixed	12
Cocksfoot	,,	5	S.143	8
Timothy		3		—
Alsike		3	S.100—1 lb.	2
White clover	S.100	$1\frac{1}{2}$	N.Z. wild	$\frac{3}{4}$
White clover	Wild	$\frac{1}{2}$	English	$\frac{1}{4}$

Very little bracken appeared amongst the young seeds. There were, however, small areas where the destruction of the bracken frond was not done in July or early August ; such land was ploughed in the autumn as a first operation. In these places stunted growth of bracken did appear in the new leys.

Approximately eighteen months after seeding down, the leys received a 15-cwt. dressing of ground limestone per acre and 3 cwt. superphosphate per acre. In February, 1948, the area seeded down in 1945 and 1946 received $1\frac{1}{2}$ cwt. per acre of nitrogen.

Stocking The Park was heavily stocked with agisted yearlings and two-year-old heifers during each grazing season from the beginning of May to mid-October. To facilitate control of grazing, it was divided into

three approximately equal plots by wire fences. Each plot contained both reseeded and untreated land, and bracken areas occurred in each. The stock were moved from plot to plot at short intervals, according to the amount of keep available, the tendency being to move more frequently during the early growing season than later on, in order to check the grass running to flower. The numbers grazed were as follows :

1945	1946	1947	1948
340	533	691	741

Naturally, with agisted stock of this kind, derived from fifty or more farms, there were a few casualties and withdrawals each year, but in the first three seasons nothing in the nature of an epidemic occurred.

In 1948, however, following a few individual cases of ailing animals in July, a considerable number of animals began to show signs of intestinal trouble, later diagnosed as symptoms of bracken poisoning.

Symptoms of Poisoning The affected animals showed a characteristic dullness, stood with their backs up, grinding their teeth, had a staring appearance and a disinclination to move or eat. There was a watery discharge from the mouth and nose, followed by bleeding from the nose, particularly if the animal was excited. The fæces were dark and loose and frequently tinged with blood. In advanced cases large clots of blood were passed ; in some the pupil of the eye filled with blood. There were several cases of a sub-acute type in which animals showing characteristic symptoms recovered within a few days when moved on to fresh pastures.

Early in September, 1948, N. H. Brooksbank, of the Veterinary Investigation Department, Tettenhall, was called in. On the evidence of symptoms and post-mortem he diagnosed bracken poisoning. Examination showed that in all parts of the Park cattle had waded into the standing unploughed bracken and browsed upon it. Here and there areas of over an acre had been bitten down to half the normal height. Evidently considerable quantities had been eaten.

As soon as the nature of the trouble was realized, owners of cattle were given the option of breaking their grazing contract and removing their stock. A large proportion of the cattle were taken out of the Park for the remainder of the season ; in most cases details of their subsequent history were obtained from the owners. In all, the following casualties were sustained :

Died in Park	9
Died after removal	11
Affected but recovered (approx.) ...	7

The Underlying Cause The circumstances of this outbreak point clearly to seasonal effects. The year 1948 was extremely good for grass. Even a stock of 700 head could not keep down the grass on 400 acres of reclaimed land. In August it was lush and rank. Apparently under such circumstances cattle develop a craving for fibrous material, which they satisfy with bracken if nothing else is available. Clearly it would be wise, in areas of this kind, to have available straw or hay which could be put down as an alternative form of roughage. But it is easy to be wise after the event.

THE CONTROL OF DISEASES OF LIVESTOCK

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THE important place occupied by livestock in agriculture cannot be overrated: a prosperous agriculture depends in considerable measure upon a healthy livestock population. This, in turn, is greatly influenced by the knowledge of the causes which give rise to the various diseases and by the methods adopted for their control. After many years during which research on these subjects was left to a few pioneers, who carried out excellent work with the limited means at their disposal, research and investigational work on health and disease problems is now being encouraged: this has resulted in a marked step forward, and measures of control for some of the economically important diseases of livestock have proved to be of great value to the farming industry.

Great Britain is in a favourable position concerning the epidemic diseases found in other parts of the world, which, on occasion, sweep through countries and even continents, leaving disaster in their wake. That dreaded disease cattle plague, or rinderpest, has been absent from this country for many years. Our position of relative security is due partly to our insular situation, partly to the foresight of our predecessors who influenced the governments of their day to bring legislative measures into operation, and partly to the exercise of close attention and care in dealing with any suspected exotic disease which may make its appearance. Periodical outbreaks of foot-and-mouth disease occur, but, generally speaking, they are promptly suppressed. Swine fever is usually present in the country but is well under control. Fowl pest (Newcastle disease) was introduced into Great Britain in 1947 and spread to many parts: by the application of suitable control measures the incidence of the disease has been considerably lowered. Constant vigilance, however, is necessary so that the first appearance of any unusual disease is recognized. The appropriate means for its suppression can then be put into operation without delay.

There exist many other diseases of economic importance, some of which can now be controlled efficiently. It may be that some of the methods of control practised at the present time are but palliatives and that better means will eventually be found. As our knowledge of fundamental processes extends, our ideas on health and disease control will certainly alter: until, however, much more research work of a basic type can be done, we shall continue to seek and apply methods of control similar to those now in operation.

Dairy Cattle The dairy cow is one of our most valuable animals and her produce is extremely important. There is a constant demand for more milk, and any factor which will lead to a further increase in our milk supply is, therefore, important. Diseases of the dairy cow are now better understood and can be controlled. Bovine tuberculosis, which is a serious disease not only from the animal but also from the human health point of view, is well under control in some areas. The encouragement given to dairy farmers to have their herds freed from tuberculosis has shown how readily those interested respond and how, within limits, it is comparatively easy to control that disease. The introduction of more reliable and potent tuberculins, the change in the method of their application and the knowledge of the interpretation of the results of tuberculin testing have completely altered our views on the eradication of bovine tuberculosis. There is, of course, a long way to go before the country will be free from this disease: there are some very "black" areas, but there is little doubt that, in time, the

disease will be eradicated completely. Bovine mastitis can now be well controlled, especially when it occurs in certain forms which have been the subject of much research.

The association of micro-organisms with mastitis is now well recognized, and control centres on their elimination from the udder, together with the adoption of measures to prevent further infection of the udder. The knowledge of the infection process has assisted considerably in devising control measures, and the valuable work of chemists in producing new chemo-therapeutical substances and antibiotics has been of the greatest help in the study of the control of mastitis. Some forms of bovine mastitis are still imperfectly understood, and further intensive study is necessary before reliable control measures can be worked out.

Brucellosis (contagious abortion) should, in the future, cause less trouble than hitherto, and losses from its presence in a herd should be completely eliminated. The setting up of resistance to the infection by the use of the newer forms of vaccine is the control method of choice. The now world-famous Strain 19 vaccine is proving its value in many countries. It must be pointed out, however, that resistance or immunity is relative to the amount and virulence of the infecting agent ; very likely complete immunity against infection in all its degrees is impossible. The use of this vaccine is, however, reducing the incidence of brucellosis to a marked degree, and the results of its application are being reflected in many herds. We still have much to learn about Johne's disease : although the causal micro-organism is known the way in which it acts is not fully understood. Research work is progressing, but it will be some considerable time before we are in a position to advise fully on methods of control.

One of the important and difficult subjects of investigation is infertility in cattle. There is a great deal of evidence that infertility, largely temporary in character, is now more prevalent than in past years. Some forms are associated with the presence of micro-organisms in the reproductive organs : as a rule it is comparatively easy to deal with the disease in this form and restore the animal or the herd to normal breeding. Difficulties arise, however, in dealing with other forms of infertility, and much research work is necessary before we shall be able to understand the complex relationship of hormones, nutrition, and other factors to reproduction in the dairy cow. The recent discovery of the presence of oestrogenic substance in certain grasses under different conditions of growth is of major importance.

Sheep Our knowledge of diseases affecting sheep has increased in recent years. We understand the causation of that large group of diseases known as entero-toxaemias, in which micro-organisms of the anaerobic group (to which sheep are so highly susceptible) produce poisons or toxins in the digestive tract and so cause heavy losses. We may not yet appreciate the exact reasons why these micro-organisms suddenly become active, but methods of setting up a resistance or immunity to the toxins have been elaborated and are now in common use.

Parasitism in sheep has been the subject of much study. External parasites—ticks which convey diseases like louping-ill, tick-borne fever and pyaemia ; the sheep maggot fly which causes extensive damage in some areas ; and the highly infectious sheep scab mite—can now be well controlled by adequate dipping with the recently introduced chemical agents, DDT and benzene hexachloride. Internal parasites can be controlled both by the adoption of suitable methods of husbandry and by the regular use of reliable anthelmintic agents, of which phenothiazine is probably the best now in use.

The study of the effects upon health of deficiencies of some of the minor or trace elements in the diet has been largely made in sheep. Cobalt deficiency is now well understood, and the addition of traces of that element to the diet, either by direct dosing, mixing with the concentrates or through the pasture by suitable manuring, controls to a marked extent the disease called "pine" in its various forms of intensity. The relationship of mineral deficiencies to the incidence of internal parasitism is also appreciated. The various trace elements are being studied one by one, and as time goes on much more knowledge of their importance will be gained.

There are diseases of sheep, of course, which are still very imperfectly understood: diseases associated with faulty metabolism are well recognized, for example, but we have still to appreciate why they arise and how they can be prevented.

Pigs and Poultry Diseases of pigs have also been the subject of much research work. Swine fever has been controlled by the legislative measures in force for the time being. Crystal violet swine fever vaccine—a recent introduction—has proved itself by large-scale experiments to be a safe measure of preventing the disease and conferring immunity for at least a year after injection. It must be remembered, of course, that this vaccine is valuable only in herds which are free from infection when it is used, and that it is not a curative agent, but merely acts as a preventive against the disease.

We still have much to learn about the relation of nutrition to disease in pigs. Some facts are well known—for example, the need for young pigs to have access to iron—but the various disturbances which occur in the digestive tract, associated with nutrition, have still to be worked out more fully. The condition referred to as "oedema of the bowel" is an example of a condition in pigs which requires much investigation.

Diseases of poultry are also much better understood nowadays, with the result that as the industry increases and regains its previous important position in agriculture, poultry farmers can adopt measures whereby much of the severe loss experienced after the first world war should not recur.

These few examples illustrate the progress that has been made in the fight against animal diseases: but research work must continue on an ever-increasing scale so that the losses from diseases in livestock can be minimized and the conditions under which health can be well maintained are more fully appreciated.

THE LIGHT TRACTOR AND THE SMALL FARM

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GREATER output is the economic order of the day. Large and medium-sized farms have increased their output by mechanization. To a less extent many smaller farms which do not come within the size category for which the standard tractor was designed have done the same. For most farmers who occupy less than 75 acres the provision and upkeep of a standard tractor costing, in round figures, £300, is an unwarranted expense. By working this machine at each job for only a short time and hitching it to implements not built for tractor towage, its full power cannot be utilized.

Small farms, which have a particular need of high output per acre, have been faced with severe problems of readjustment and have had to rely upon a variety of aids towards a policy of greater self-sufficiency. Their output, however, seems not to have increased as much in proportion to capital and labour employed as it has on the larger farms, and for the last two or three years the cost of labour has been a heavy charge on the business. The merging of holdings has been suggested; it could well be associated with mechanization. A relatively cheap and adaptable source of mechanical power should help in reaching a more favourable ratio of output to cost on these farms.

It is not possible to differentiate in general between the circumstances where the remedy would be to reduce costs more than output and those in which the remedy would be to increase output whilst not increasing costs proportionately. In practice the decision as to the course to take is probably connected with the replacement of a standard tractor by a light tractor in the first case, and with changing over from horses to the light tractor in the second. An attempt is made later in this article to assess the economy of the light tractor in each instance.

The lighter and cheaper machines available today cannot readily be substituted for either tractor or horses on small farms. They have been designed primarily for tillage operations; their two-wheeled chassis gives a high efficiency in this use, and justifiably they have become popular for horticultural work. On the small farm something more is required from them. Harvesting, haulage and barn work may account for one-third of all tractor-hours on the mixed farm, and even more on a stock farm. The advantage in output per unit of both time and cost which the machine offers in tillage and barn work does not apply to harvesting and hauling. Speed over the ground (2½ m.p.h.) is slow, and the weight of load which they will comfortably haul (15 cwt.) does not compensate adequately.

It is the relation between the total of tillage work and the importance of the winter stock-food harvest which will decide whether any general benefit would follow the introduction of the light horticultural type of tractor on the small farm. A machine better adapted for draw-bar work, having a higher and more flexible effective haulage rate, backed by good servicing facilities and yet combining the versatility and low cost of two-wheeled tractors, would be much more useful. This is the type of light tractor—and several models are now being developed—whose performance is now considered. Reliance on contract work for the heavier jobs would still be necessary, but the machine would be closer to the scale of the existing labour force and operating equipment on small farms. As a general principle, the intensive arable farm stands to gain more from mechanization than the intensive stock farm; though there is no denying that a variety of uses has been found for small machines on all sorts and conditions of farms.

THE LIGHT TRACTOR AND THE SMALL FARM

A guide to the cost of operating the ordinary two-wheeled light tractors is given in the accompanying Table. It relates to a 3½ h.p. machine worked for the two years 1946 and 1947. Drilling and cutting of grain crops were done by contractor. It is seen that the tractor worked 900 hours. Set beside the recorded figures, however, are estimated costs for an assumed full utilization of 1,400 hours a year.

Hourly Cost of Working a Light Tractor

	As Recorded, for 900-hour Utilization							Comparative Cost Estimated for 1,400-hour Utilization					
	£	s.	d.	£	s.	d.	per cent	£	s.	d.	£	s.	d.
Running Costs													
Petrol, 190 gal. at 2s. 1½d. per gal.	20	3	9				33.2	31	7	2			
Oil, 24 gal. at 8s. per gal.	9	12	0				15.8	14	8	0			
Repairs (materials and labour)	2	12	6				4.3	4	0	6			
Daily attention (labour at 2s. per hr.)	2	0	0	34	8	3	3.2	3	0	0	52	15	8
Overhead Expenses													
Road Fund licence and insurance	1	0	0				1.6	1	0	0			
Routine attention and maintenance	3	10	0				5.8	3	10	0			
Depreciation	22	0	0	26	10	0	36.1	27	0	0	31	10	0
Total Cost per Annum ..				£60	18	3	100.0				£84	5	8
Cost per Hour				16.24d.							14.45d.		

(Petrol consumption has been charged at the rate of 1.7 gallons per day of eight hours, oil consumption at 0.8 pints, on account of the drip-feed to chains, with a change of oil after every 50 hours' running. Five minutes a working day has been allowed for greasing and attention. Routine maintenance includes decarbonizing at six-monthly intervals. Depreciation has been calculated proportionately to working time over two years on a reducing instalment system of 22½ per cent per annum.)

From a knowledge of working costs and work performance it is possible to estimate the relative economy of the light tractor against both standard tractor and horses. In comparison with the standard tractor, the cost of working a light tractor is high for a given amount of work. Taking the machine alone, the work done per unit of cost is 15-20 per cent less, and when the cost of an adult driver's time is added that figure falls to 40 per cent. Only if the standard machine and its driver were idle for two-fifths of their normal working year—a most unusual eventuality—would the light tractor begin to compete. Assuming the average case that the two-wheeled machine can do three-eighths of all the work of the larger machine in the same time, there would be no saving in the cost of tractor labour until the tractor-man unit was being used productively for only 300 hours a year. In terms of farming systems this means that the size at which a light tractor could economically replace the larger machine would be about 60 acres for grass farms with 70 per cent of permanent grass, 40 acres on mixed farms with 50 per cent of permanent grass, and 30 acres on arable farms with 25 per cent of permanent grass.

When the figures are compared with recently published costs of horse labour*, it will be seen that the annual cost of a two-wheeled tractor working about 900 hours a year is at present a little more than that of keeping one horse. The slightly faster rate of working, depending upon the operator, is a factor to be taken into account, and for management purposes it can be said that a job which takes a horse team ten hours can be done by the machine in eight. The real advantage in the field is greater than this, for cutting down stable work means further saving. Thus, if the tractor were to replace a two-horse team working 1,200 hours throughout the year, there would be a direct saving of 40 per cent in cost of motive power as well as a saving of 240 man-hours. If the machine were to take the place of only one horse throughout the year and still get through 20 per cent more work in the same time, the extra cost of the tractor would be saved in labour. Even if the tractor did the work of horses at the same rate as horses, the light tractor would be economic whilst working 900 hours a year, so long as it could be kept on two-horse work for 60 per cent of its working time. Where the machine could be worked for 1,400 hours a year, there would be a potential increase of 2½ times the work output per man, compared with that given by one horse, for a one-third increase in the cost of farm power.

Complete assessment of the position is hampered by the great difference between the horse-power supplied by tractors and their effective rate of substitution for horses. Although it is said that the tractor can do the work of six horses, in practice only three are replaced. Should the situation arise that 1,200 horse-hours on the 40-acre mixed farm were replaced by 800 light-tractor hours instead of by 400, any benefit from mechanization would be confined to a shorter working year. Assuming an advantage of one-fifth over a two-horse team, and that one-third of all tractor hours are taken up by non-tillage work, a mixed farm of 60 acres could, with ideal organization, be handled with a light tractor of the type envisaged. The figure of 40 acres given previously is a measure of the wastage where tractors are not used to capacity and of the increased demands upon motive power made necessary by the farming self-sufficiency campaign.

Thus so long as high farming is the rule there is likely to be only limited scope for employing the light tractor in place of the standard machine, because opportunities for profitable employment of the time saved by the latter can usually be found. The same considerations foreshadow an extension of mechanization to smaller farms at present relying upon horses and contractors. Due regard must be paid to the latent dangers of over-capitalization in pressing the new machine into use on a farm which is too small to provide enough work for it, or where marginality in any factor makes increased output too expensive. But when performance can be balanced with cost in a light tractor, gains in productivity and savings in labour on small farms can be considerable, particularly where a farmer is single-handed or where tillage and the "cropping" of grassland have been superimposed on predominantly livestock farms.

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* Compare average cost per horse-year, £59 13s. 7d., and per horse-hour, 10d. (1940-47), A. J. Marval, Horse Labour Costs at the Lord Wandsworth College, 1937-47, *Agriculture* (February, 1948) or £53 8s. 10d. and 10.22d. (1944-45), J. Wyllie, The Cost of Horse Labour and Tractor Work, *Wye College, Department of Economics, Report No.* 38 (1946).

THE EFFECT OF TEAT-CUP ASSEMBLY WEIGHT ON RATE OF MACHINE MILKING

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Earlier articles relating to this subject have appeared in this Journal in March, 1947—"Efficient Milking," and September, 1948—"Residual Milk"

All milking machine operators who have attempted to adopt quicker methods have been hampered by the very slow milking cow. Dodd and Foot [1] have pointed out that cows show marked individuality in their rates of milking and that it is very difficult to speed up the rate by changes in management. A common method is to increase the weight of the teat-cup assembly by lodging weights or bricks between the short milk tubes. The following short-term experiment was designed to discover the effect of this practice on milking rate and yield.

The experiment was carried out with six cows giving from 2½ to 5 gallons of milk per day and varying in the total duration of morning milking from 5½ to 11 minutes. The milking machine used was of a standard bucket type, fitted with moulded teat-cup liners and operated at a negative pressure of 14 inches of mercury and a pulsation rate of 42 per minute. The teat-cup assembly in normal milking position weighed approximately 7 lb.

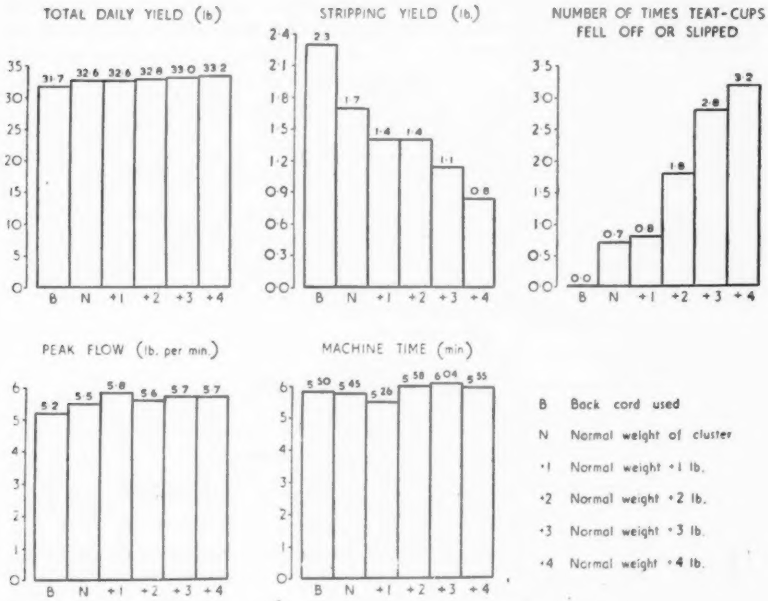
Six Weights Compared Six different weights of teat-cup assembly were compared. These treatments were randomized, so that every cow had each treatment once in a six-day period and no two cows had the same treatment on one day. The weight of the teat-cup assembly was altered by supporting it with a back cord in one treatment and by adding weights up to 8 lb. in other treatments ; 6 or 8 lb. added to the normal weight of the assembly was found to cause a good deal of irritation, and the teat-cup fell off so frequently that the treatment had to be abandoned. For the next four periods the weights were :

Normal teat-cup assembly with support
,, ,, ,, without support
Teat-cup assembly + 1 lb.
,, ,, + 2 lb.
,, ,, + 3 lb.
,, ,, + 4 lb.

The amount of milk produced was recorded daily, and the milking rates were obtained by suspending the milking machine on a spring balance and taking readings at 30-second intervals, as described by Foot [2]. Machine stripping began when the rate of milk flow fell below 0.4 lb. per minute, and the milker removed the teat-cup when he considered that milk had ceased to flow. The number of times that the teat-cups fell off or had to be prevented from falling off was recorded at each morning milking.

The effect of the treatment on milk yield and milking rate is shown on p. 213. Total daily yield shows an insignificant increase with each weight increment. The effect on yield of machine strippings, however, is very marked and statistically significant ($p=0.01$) : the addition of the 4-lb. weight reduced the strippings to one quarter of those obtained when the back cord was used, probably because the weights prevented the teat-cups from crawling up the teats and stopping the free flow of milk through the teat sinus[3]. Unfortunately, this advantage is obtained at the expense of an increase in the number of times the teat-cups slip or fall off during milking. The cows differ markedly in their ability to carry the weighted teat-cups : one cow milked successfully with an additional weight of 4 lb. ; two others needed occasional adjustment to the teat-cups when the 1lb. weight was added.

EFFECT OF TEAT-CUP ASSEMBLY WEIGHT ON MILKING RATE



The effect on rate of milking was slight. The "peak flow," or milking rate in the minute of fastest milking, was little affected. The normal teat-cup assembly was found to give a slightly increased peak flow, compared with the results when the back cord was used, and the addition of a 1-lb. weight gave a further slight increase. Though these increases were reflected in a small reduction in the machine time (i.e., the duration of milking up to the start of machine stripping), these changes are minor compared with the very great differences between the individual cows in peak flow and milking time.

From this small experiment certain practical lessons can be drawn. Cows which milk slowly throughout the whole process and leave very little milk to be removed by hand or machine stripping will show almost no improvement if additional weights are added. Cows whose udder and teat construction is such that the teat-cups readily crawl up the teats and prevent the removal of large quantities of milk without prolonged hand or machine stripping will milk more completely and efficiently if weights are used. This is practical, however, only if the cow's teats are such that the teat-cups hold quite firmly and if the cow is not irritated by the weights. It is also clear that the back cord should be used only when absolutely essential. This work confirms the observations of Maddever and Egdell [4], who found that in herds where back cords were used the total duration of milking was high.

This experiment suggests that for most cows the 7-lb. weight of the teat-cup assembly used is quite sufficient to ensure that machine or hand strippings are kept at a low level—a deduction confirmed by an analysis of the routine speed of milking records taken in the Reading Institute herd. This analysis shows that for 100 unselected cows milked with a normal assembly, the average amount of machine strippings is under $1\frac{1}{2}$ lb. at each milking.

It should, however, be pointed out that these results apply to one particular design of teat-cup liner, and though changes in shape of liner are

not likely to produce major changes in milking rate they may markedly affect the amount of machine strippings and the frequency with which the teat-cups fall off the cow.

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THE FENLANDS

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(A Paper read to N.A.A.S. and A.L.S. officers in the Eastern Province, July 1, 1949)

THE Fens cover approximately 800,000 acres of land around the Wash, stretching from the southern and eastern parts of Lindsey in the north, almost to the town of Cambridge in the south, covering a long, rather narrow stretch of land varying from 15 to 35 miles in width and some 70 to 100 miles in length. Most of the area lies within a few feet of sea-level, much of the black fen being at or below sea-level. It includes some of the most fertile farm land in this country, but its continued productivity is obviously dependent on an efficient system of artificial drainage.

The Fens were originally an estuary of which only the Wash now remains. The area is a shallow basin filled on the seaward side with silts and clays laid down in brackish water and on the landward side with peat formed under fresh-water conditions. In many places there is evidence of alternating marine and fresh-water conditions giving rise to alternate layers of silt and peat. The waterlogging was produced in part by the discharge into the area of numerous large river systems draining the uplands on the west and south of the area, and the fact that much of this water came from calcareous formations largely prevented the development of the acid type of peat one might otherwise have expected.

The floor of the basin was a relatively flat strip of Jurassic clay covered in places by other clays, such as Boulder clay, and, until conditions became favourable for peat formation, the area carried forests of oak and other trees (pine, alder and willow) rooted in the clay. The trees were first killed by waterlogging and submergence and then preserved by the accumulating peat, a condition in which many have remained until dug up in the course of drainage and reclamation work some five thousand years later. Large stretches of water, or meres, were formed in many parts of the fenland, e.g., Soham, Ramsey and Whittlesey, and these remained long after the early attempts at drainage, the last of them being artificially drained about a century ago.

The clay floor of the basin was not entirely level and hence islands of Jurassic clay, sometimes capped with Boulder clay or gravel, even now stand up above the peat deposits, e.g., Ely and Littleport.

The southern end of the Fens was farthest from marine influences, and here the deposits are chiefly peat, brown or black in colour and formed from decayed fresh-water plants such as sedge and Phragmites. To the north of the area, where marine conditions were prevalent, tides brought in considerable quantities of mineral material and the deposits are chiefly silt. In all, the silt deposits cover about 450,000 acres and the so-called black fen about 350,000 acres, chiefly at the southern end of the area, but with a narrow strip running up the west side and occasional pockets in other parts of the area.

The Fens were inhabited in pre-Roman times and no doubt there was some attempt at artificial drainage both then and during the Roman occupation, but the most important phase of drainage activity began in the seventeenth century, and from that time date most of the big straight drainage cuts or channels such as the Bedford Levels. Though the main scheme of drainage may be said to have been completed by the middle of the nineteenth century, maintenance and improvement have called for continuous effort since, and many difficult problems have developed.

Aeration and cultivation, following improved drainage, have led to shrinkage and wastage of the peat, and this in turn has produced a new problem in drainage. It has been estimated that two hundred years of drainage have lowered the peat surface by some 10 feet, and in some places the level of the fen peats before drainage was as much as 16 feet higher than at present. The lowering of the land surface is illustrated by the fact that the beds of former rivers diverted from their natural course many years ago now appear as silt ridges or "roddons" well above the level of the surrounding peat surface.

The figure usually given for wastage in cultivated fen is approximately ½-1 inch per annum, but the rate is much higher than this in the first few years after reclamation (4.75 inches per annum in the first twelve years in Denton Fen (Holme Post)).

As the level of the land surface falls, embankment of the rivers becomes more difficult and costly, and water has to be "lifted" a greater height from field drains to river.

Farming on the Black Fen Soils derived from silt deposits have very different agricultural characteristics from those derived from peat. The silts are a fine alluvial deposit varying in texture, but all are generally good agricultural land with deep soils resistant to drought. The main crops are potatoes, wheat and sugar beet, but considerable acreages of special crops have been grown in recent years, particularly peas (for canning and processing), brassicas of various types, bulbs and so on, as well as considerable acreages of fruit, especially round Wisbech.

The black peats which lie chiefly in the Isle of Ely, West Norfolk, West Suffolk, North Cambridgeshire, East Huntingdonshire, Soke of Peterborough, South-west Holland, Parts of Lindsey and East Kesteven consist of an accumulation of organic matter of varying depth overlying various types of mineral deposits. It is with these peat areas that this article is chiefly concerned, and here it is necessary to emphasize the marked variations from place to place, both in the depth and character of the alluvial deposit as well as in the type of underlying mineral material.

In the so-called black fen area there are frequent patches of what is known as "white fen," i.e., peat containing a high percentage of shell material; gravel fen, i.e., peat overlying gravel, and where the gravel is near the surface the surface soil may be a mixture of peat and gravel; and sandy fen, i.e., peat overlying sand and often mixed with considerable quantities of sand.

In other districts the surface peat may be relatively shallow and mixed with clay particles from an underlying clay formation. Where the peat is relatively shallow and mixed with mineral particles from the underlying mineral formation, the land is generally described as "skirt fen". Not only will admixture with mineral particles affect the agricultural characteristics of the peat, but the depth of peat and the nature of the underlying mineral material also have a profound effect.

It is common practice to speak of black fen as if the term denotes a single relatively uniform soil type, but this is not the case. The soil of the fen area varies widely from place to place, and the variation may be very sharp, a single field containing several very different soil types, though there are, of course, considerable stretches of good black fen of relatively uniform type.

To a large extent farming on the black fen is influenced by the free-working nature of the soil, its relative richness in reserves of nitrogen and relative freedom from drought due to the maintenance of a fairly high water-table. It is eminently suited to the production of potatoes and root crops generally. It is often said that few fen farmers farm on any set rotation of crops, and up to a point this is true for individual fields, but even on farms with no set formal crop rotation, the proportion of the farm-acreage under each crop is much the same as on farms where a strict rotation is followed. Opportunism is largely a matter of field policy rather than farm policy in this respect.

Broadly speaking, fen peat farmers follow either a three- or four-course rotation so that anything from one-half to two-thirds of the arable land is under root and vegetable crops with from one-third to one-half under cereals and usually only very little temporary or permanent grassland. The three-course rotation is : potatoes—sugar beet, mangolds or market-garden crops —cereals.

The exact order in which these three types of crop are taken may vary between farms. There is more time to sow winter corn after potatoes than after beet, but winter wheat can be sown later on fen than adjoining highland soils. Also, sugar beet gives a better chance to kill self-set potatoes than does corn, unless some spray treatment can be used. Self-sets help to perpetuate potato root eelworm and their haulm is a nuisance in a cereal crop at harvest time. In an attempt to widen the rotation and reduce the frequency with which sugar beet and potatoes are taken, on some land an additional cereal crop may be introduced between potatoes and sugar beet giving : potatoes, cereal—sugar beet or market-garden crop—cereal. This rather greater proportion of cereal crop is perhaps more characteristic of the skirt land than the true black fen.

In the black fen, potatoes are chiefly second early and maincrop. The area is subject to late frosts and therefore unsuited to first earlies.

The chief cereal crop is wheat, generally about two-thirds of the total cereal acreage, and though it is less subject to lodging than oats or barley, large areas are often "laid" at harvest. Attempts may be made to control a crop that is too forward in the spring by severe harrowing, grazing with sheep or cattle in late April or early May if dry enough, or by spraying with sulphuric acid to check the crop as well as control weeds.

Barley is not only more liable to lodging than wheat but conditions inevitably lead to the production of a coarse sample with a high nitrogen content, generally unsuitable for malting. In general, cereals are not popular crops with the fenland farmer. Yields of grain on fen peats are not high by comparison with yields of other crops ; difficulties at harvest may seriously increase the cost of production, and quality of grain is often poor. Potential cash returns per acre are low by comparison with the potential return from potatoes, carrots, etc., but the inclusion of cereals in the cropping of fenland

is virtually essential to avoid too frequent cropping with potatoes and sugar beet on any but very small farms.

Sugar beet is now almost as important as potatoes to the fen farmer and there is a noticeable concentration of sugar beet factories in and around the whole fenland area (including the silts), though sugar contents are often low on the more peaty types of soil.

Prior to the introduction of sugar beet, considerable acreages of mangolds were grown, partly for feeding to stock in yards during the winter and partly for sale to stock-keepers in other parts of the country. A small area of mangolds is still to be found, but the crop has very largely been replaced by sugar beet, and indeed the whole system of fenland cropping is based as far as possible on cash crops.

Among the smaller acreage crops, carrots still occupy a considerable area, while chicory for drying has increased since the establishment of the factories at Needingworth and Lakenheath. Mustard and rape (coleseed) are grown for seed and, where the water-table is suitable, celery is an important crop.

Roads It has already been stated that from one-half to two-thirds of the area may carry potatoes, sugar beet and similar bulky crops. However suitable the land may be for the production of these crops, an important consideration in their cultivation is the harvesting and cartage of the crop from the field to market or factory. Anyone with any experience of peat will realize its unsuitability as road material, and in the past the cropping of much fenland was determined by its accessibility. Many of what on highland farms would be hard farm roads and cart tracks, capable of carrying ordinary farm traffic during the autumn, would be peat tracks or "soft roads" in the Fen. Although these are to some extent held together in the summer by grass, weeds and (particularly) couch, they are obviously unsuited for heavy carting in the autumn and early winter months.

Equally, fields which can be reached only by crossing other fields present considerable difficulties in clearing bulky crops in the autumn. There is always the temptation, therefore, to concentrate the acreage of potatoes and sugar beet on fields that are near to a hard track (which must have been made artificially as distinct from the ordinary farm cart track along a headland on highland farms) or, at least, to a soft road or driftway. This, in part, may be responsible for the seeming absence of a proper rotation of crops on individual fields, even though the farm carries the standard proportion of crops found in a typical rotation.

The importance of access, if the most suitable crops are to be grown, has led recently to the construction of hard roads in many fenland areas. These may be of gravel, chalk or concrete, depending on the presence of suitable material in the neighbourhood and the amount of capital available. In any event, such roads must be costly where materials are rarely found on or close to the site, and this was one of the problems that had to be faced in the war-time reclamation of many derelict fens.

Grass Little mention has been made of grass in connection with fenland crops. Before the war, grass was rarely found on any but the poorer types of skirt fen. Arable farming was regarded as more profitable, and the only grass on many peat fen farms was a paddock for such horses as were kept and an odd cow or two. It is, however, not easy to decide whether the absence of grass is due to the more general suitability of the land for arable cropping and the bigger potential return from arable crops or to the possible unsuitability of the area for livestock making it difficult to "cash" the grass.

In the past the most popular grass was a one-year ryegrass ley, sometimes cut for seed. It has been difficult to establish good permanent grass or long leys on fen peat soils. Clovers, though sometimes present in the first year or two, rarely persisted, and the sward rapidly deteriorated. In recent years a few farmers have attempted to apply modern methods of grassland management on the fen with some success, and the chances of establishing long leys certainly seem better now than thirty years ago.

In addition to the poorer skirt fens which were left in grass when it was considered unprofitable to use them for arable cropping, fairly extensive areas of grass exist in the so-called "Washes". These are really emergency reservoirs alongside some of the main fenland rivers. They are frequently flooded for varying periods during the winter months and improvement is therefore difficult, but they have a high reputation as grazing land and carry considerable numbers of stock during the summer months.

Livestock Reference has already been made to the fact that arable cropping is the main feature of fenland farming. On many farms no livestock of any sort are kept, but many farmers have attempted to introduce livestock into their farming systems, partly to utilize crop residues which might otherwise be wasted, and partly to supply farmyard manure. Sugar beet tops, chat potatoes, tail corn and unsaleable vegetables provide considerable quantities of stock food, whilst the cereals produce a good deal of straw that must be disposed of in one way or another.

During the summer months the absence of large areas of grazing leys reduced the stock-carrying capacity of fenland farms (except those which had access to "Wash" or other grazing), and this led to the winter fattening of cattle in yards as the chief livestock enterprise on those farms desirous of keeping stock.

A fall in prices led to the replacement of cattle by pigs in the late 1920s and the 1930s. Like many highland farmers, some fen farmers reduced their pig-keeping activities during the war, and a few returned in a small way to the feeding of cattle or carried store cattle through the winter. Recently, cattle have been used on a few farms to feed-off sugar beet tops.

Sheep have never been a prominent feature in the Fen, and though small acreages of sugar beet tops have been fed-off by sheep in recent years, this practice has been most common on farms at the edge of the Fen, often with some land out of the Fen so that the sheep spend only part of their time in the Fen consuming crop residues. Alternatively store sheep may be brought in specifically to fatten on sugar beet tops, staying no more than three to four months in the Fen. On most farms, however, beet tops are still ploughed in.

Three important considerations arise in connection with the keeping of livestock in the Fen :

First, not only are farm buildings suitable for housing livestock relatively rare, but they are difficult to erect and maintain because of the uneven sinking of the Fen, which leads to collapse of the buildings. Such buildings as exist are generally of a temporary nature, except in those places where it is possible to erect the building on a good foundation, i.e., where the peat is thin and overlies a suitable stable mineral deposit.

The second difficulty is in connection with containing livestock within the boundaries of the fields. In most fenland areas, field boundaries consist of open dykes which are an important feature in the drainage of the area and which must, therefore, be kept clear. Hence stock must be kept out of these dykes, not only for the sake of the stock but for the sake of the dyke itself, and many farmers consider it desirable to wire a field so as to prevent stock treading-in the sides of the dykes. This obviously adds to the cost.

The third consideration is a supply of water for stock. Some farms have shallow wells, but these are unreliable and many farmers have to rely on dyke water for their livestock—for those in buildings as well as those out on the land. Rainwater collected from roofs of buildings may also be used for stock in yards. This obviously creates difficulties and virtually precludes some types of livestock husbandry in parts of the Fen.

It has been said that field boundaries are often open dykes, and this is generally true throughout the fenland area. Live hedges are almost non-existent, and other forms of fencing are essentially of a temporary nature and associated only with those farms and fields which carry livestock. Trees are also relatively rare. The absence of live fence and trees may in some districts be associated with "blowing".

Fields are for the most part regular in shape, usually square or oblong. Their size is largely determined by drainage needs and they must not therefore be too large, a point that must not be lost sight of in connection with the efficiency of mechanization.

Cropping Problems On the lighter peat soils it is difficult to get a firm tilth but, in general, cultivations are easy, draught is light and periodical deep ploughing is commonly practised. The wisdom of this has been called in question in view of the difficulty of getting proper consolidation for some crops, but thorough cultivations are partly concerned with weed control.

Weeds grow even more vigorously than crops. This applies equally to annual weeds like chickweed and perennials like couch and twitch. Annuals could no doubt be controlled, in part at any rate, by the use of chemical sprays, but the Fen farmer still relies to a large extent on hoeing. Perennial weeds like couch and twitch can as yet be controlled only by proper cultivations providing an opportunity for dragging them out, collecting them up and carting them off the field to be burnt.

A good deal has been heard in recent years about the blowing of light fen soils. Blowing can be serious and may result in the removal of the top inch or so of soil. It occurs chiefly in the spring and is most severe on the light peaty fens or sandy peats that are to carry a spring crop or have already been sown with a spring crop. It may result in the complete removal of the surface soil, together with sown seed, involving the complete resowing of the field sometimes two or three times in one season. What is worse, the blown soil may be deposited in the open ditches, thereby blocking the drainage system of the area and involving additional expense in cleaning out the ditches before the next winter if the land is not to be waterlogged.

The trouble is less serious and less prevalent on fens that have been "clayed". By "claying" is meant the excavation of underlying clay or silty clay material for spreading on the surface of the ground. This practice was common prior to 1917, but has become increasingly rare since that time owing to the amount of labour required and the cost involved. The cost will be appreciated when it is realized that the operation usually involves the spreading of some 200 tons of clay per acre.*

Opportunist cropping and neglect of the common principles of crop rotation have from time to time brought trouble to the Fens, particularly in the shape of potato root eelworm and sugar beet eelworm. To devise a cropping sequence which will achieve the potential maximum output from Black Fen, and yet at the same time have proper regard for the principles of crop rotation, is not easy in the Fen peat districts.

* An article by R. B. Ferro and A. C. Middleton on the costs of marling in East Yorkshire appeared in the June issue of *Agriculture*.

The Fen farmer has always tended to look at each crop as an individual, almost as a separate part of his farming activities, and to assess its value on the basis of its direct cash return. This outlook can only lead to trouble until such time as other methods of control of pests and diseases are available. The effect of a crop on the soil and on succeeding crops is of first importance.

There is, of course, no dearth of other pests in the Fen, but I have mentioned these two because of their outstanding importance in Fenland agriculture and the need for a proper realization of this in the interests of the future of Fenland farming.

Of diseases, Potato Blight must obviously be of importance in an area such as this where humid conditions are so liable to develop during the summer months and where the prosperity of the area depends so largely on the potato crop.

The only other disease I would mention as being perhaps specially favoured by conditions in the area, as compared with conditions in other parts of the country, is mildew of cereals, which can develop to an almost unbelievable extent in some seasons.

Trouble may also arise sometimes from trace element deficiency.

Labour No account of Fenland agriculture would be complete without some reference to labour. For the most part, the population of the Fenland districts is concentrated in villages, usually on one or other of the islands already mentioned as being outcrops of the mineral formation (clay or gravel) or on the edge of the adjacent highland. This distribution is necessitated partly by the difficulty of building in the Fen (already mentioned), difficulties of water supply and the provision of other amenities in the Fen, and by the general unwillingness of most people to live in the Fen itself.

The Fen worker is one of the most efficient and highly skilled agricultural workers in the country, and though the Fen farmer has not been slow to avail himself of labour-saving machinery, the amount of manual labour involved in the growing of the root and vegetable crops in particular is still large. Much of the work is done piece-work and a great deal is done on a casual basis by the family of the permanent farm worker, particularly in connection with planting and lifting potatoes, singling, hoeing and lifting of sugar beet.

The large proportion of smallholdings in the Fen has resulted in many workers having a small 5- or 10-acre holding of their own whilst working for a larger farmer, and the proportion of large farms is not high. Smallholdings have developed on a large scale in the Fenland areas. The productivity of the land, combined with its relatively easy working nature, makes it specially suitable for this purpose.

The intensive nature of the agriculture of the Black Fen is shown by the fact that farm capital, manual labour and gross output per 100 acres are all very high, often double the comparable figures for adjacent highland farming.

Wicke Sedge Fen, in the possession of the National Trust, showing land in its original condition, similar to that which has been reclaimed by drainage. This land and that on Burwell Fen is some 15 feet below sea level.

Bog oak from adjoining fields lying alongside a concrete road. Near the surface they interfere with cultivations and must be removed. Some are more than 70 feet long.

The Old West River in summer, showing the "wash" between the river and the bank that retains the water in times of flood.

Fenland rivers are embanked to carry flood waters.

The larger watercourses have their uses. Barges conveying sugar beet to the local factory.

THE OUTWINTERING OF BEEF STORES ON GRASSLAND (See pp. 200-3)

Block A. Range grazed.

Block B. Divided into twelve paddocks by electric fencing

RECENT RESEARCH ON WIREWORMS

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IN a report by the Advisory Entomologists' Conference of a wireworm survey of England and Wales undertaken in connection with the ploughing-up campaign in 1939-42*, a sampling method described for estimating wireworm populations led to the possibility of reliable practical advice being given to farmers throughout the country. As a result of figures obtained and experience gained from sampling large numbers of fields, it was possible for advisers to suggest cropping adjustments which often helped farmers to avoid serious losses. It was previously known that some crops, e.g., peas and beans, were much more resistant to wireworm attack than others. This knowledge was considerably extended, and as a result of advice given many war-time cropping programmes were modified, thus leading to considerable increases in food production. Advice based on the results of this survey is still given, but meanwhile there have been many important advances in our knowledge of the wireworm problem, and it is the purpose of this article to describe the progress of research on wireworms in this country since the issue of the report in 1943.

Evidence from the survey indicated that spring oats is one of the farm crops most susceptible to wireworm attack, and trials with this crop were therefore continued throughout the country. These were described by Finney and Jary[1], who showed that in fields with high wireworm populations the chance of a satisfactory crop of spring oats is increased considerably by sowing extra seed ; 50 per cent extra seed increased the yield by as much as 3-5 cwt. of grain per acre. A similar though less marked effect was produced by cross-drilling seed without any increase in the total amount sown.

Observations on wireworms in the sugar beet crop, by Price Jones and F. G. W. Jones[2], also emphasized the importance of an increased seeding rate as a control measure. Increasing the seed rate from 14-16 lb. per acre to 17-25 lb. per acre in fields of high wireworm population gave significantly higher plant populations in most trials and also an increase of 15 per cent in total sugar in the one trial harvested. Interdrilling with wheat to act as a trap crop at 40-70 lb. per acre gave increased plant populations of sugar beet before and after singling. It was recognized, however, that neither interdrilling with a trap crop nor extra seeding was an ideal way of dealing with wireworms because, paradoxically, control depended on giving the insects extra food. It was important, therefore, to press on with research already under way.

New Methods The estimations of wireworm populations described in Bulletin 128 were based on a hand-sorting method of examining the samples. This was adopted because no other quick method was available at the time and the need for the work was urgent. The figures obtained provided a basis for practical advice, but it was realized that the numbers of wireworms found by this method by no means represented the total population present, and a study of methods of extracting all wireworms, including the very small ones, from the soil was undertaken at the Department of Zoology, Cambridge, by Salt and Hollick[3]. These workers evolved and described a mechanical method which provided for the extraction of complete populations of insects from soil samples. They showed that, as with all animals,

* *Ministry of Agriculture Bulletin* 128, "Wireworms and Food Production". H.M. Stationery Office. Price 1s. (1s. 2d. by post).

in order to maintain a certain population of fully-grown individuals, far larger numbers of young have to be present because of high mortality in the early stages. An animal population may thus be represented by a pyramid or cone in which the large numbers of small individuals, newly-hatched from eggs, form the base and diminishing numbers of larger individuals are found until a comparatively small number of fully grown individuals or adults survive at the apex. Salt and Hollick showed that approximately 60 per cent of the wireworm population in grassland consists of larvae less than ¼-inch long. Very few of this size were found by the hand-sorting method. Total extraction showed that the wireworm populations of some fields totalled more than ten million per acre, and of some small areas more than twenty million per acre.

Using the new extraction apparatus, these workers([4]) were able to study wireworm populations much more accurately than had hitherto been possible. They set out to find how wireworms were distributed in a fairly small area, what caused the distribution, and how the observed distribution came about. They found that over a period of three years some spots in a field were consistently three or four times as heavily infested as others only 4 yards away. Within the ¼-acre plot studied intensively the amount of soil moisture at a depth of 3 inches was found to be the most important factor. Other factors correlated with wireworm numbers were the amount of organic matter and nitrogen in the soil and abundance of certain grasses and certain other insects. The authors emphasized, however, that much more work on the ecology of wireworms would be needed before a full explanation of some of their findings could be expected.

The final paper in this series by Salt and Hollick, dealing with the effect of cultivations on wireworm populations, was published recently([5]).

Using the laboratory apparatus as a basis, Hollick designed and supervised the building of a prototype of an ingenious and intricate machine for the rapid and complete extraction of all wireworms from soil samples. This machine is, in principle, a combination of four units of the type of apparatus built by Salt and Hollick in the laboratory. It was designed so as to make it possible, after soaking the samples for twenty-four hours, to put them in at one end of the machine and count the wireworms extracted at the other. The prototype machine was thoroughly tested at Rothamsted and was shown to be very efficient. Over 99 per cent of the wireworms present in a sample could be recovered and five or six samples per man-hour could be handled. Other soil-inhabiting insects could also be extracted, but for some purposes the machine will probably prove to be too intricate and costly.

About this time, and following the development of the Salt and Hollick small-scale wireworm apparatus, another team of Cambridge workers, Cockbill, Henderson, Ross and Stapley ([6]), using the same principle, constructed a large-scale flotation apparatus for extracting wireworms from the soil. The apparatus was less intricate and much cheaper than the Hollick extraction apparatus described above. These workers did not aim at the extraction of all wireworms, including the very small ones, as with the Hollick machine ; nevertheless it was found in practice that over 95 per cent of the wireworms were extracted. By this method ten samples of soil (4 inches in diameter and 6 inches deep) bulked together could be examined at one time and could be dealt with at the rate of thirteen samples per man-hour. Small-scale models of the apparatus have been installed at some provincial advisory centres and have helped to increase the accuracy of wireworm sampling work.

Laboratory Studies While the above work was proceeding other workers at the Zoology Laboratory, Cambridge, undertook studies on the "behaviour" of wireworms. When kept in dry conditions wireworms are liable to lose weight very quickly—due to loss of water through the skin or cuticle. Lees[7], however, showed that by means of certain minute sense organs on the head, wireworms are able to avoid dry air. He also showed[8] that wireworms will quickly migrate out of dry sand and collect together in wet sand, and that the feeding activity of a small population of larvae was much greater at low than at high temperatures. Falconer[9], of the same laboratory, showed that the resistance of wireworms to low temperatures was greatly influenced by the rate at which the temperature was reduced. For instance, a sudden drop in temperature to about 19°F. (13 degrees of frost) killed all the wireworms in four hours, but when the temperature was lowered gradually a few survived for at least a day at 14°F. (18 degrees of frost); it was concluded that very few, if any, wireworms are likely to be killed by the temperatures normally encountered in soils in this country. Falconer[10], also found that wireworms are extremely sensitive to light, but their objection to light did not prevent their emerging from the soil and crawling on the surface if the atmosphere was sufficiently moist.

Thorpe and Crombie, co-operating with Hill and Darrah[11], of the Agricultural Research Council Unit of Plant Biochemistry, Cambridge, studied the behaviour of wireworms in response to chemical stimulation, with a view eventually to using a baiting method for their control. Two types of apparatus were used; one tested the biting reaction of wireworms, and the other—"a soil choice chamber"—their ability to aggregate in sand or soil mixed with certain test chemicals. They found a definite response to pure sugars but a much increased activity in response to potato juice with the starch grains removed. Certain colourless crystals, later found to be a chemical known as asparagine, isolated from the juice, stimulated the wireworms to even greater activity; further, it was shown that aggregation of wireworms was also caused by a number of compounds related to asparagine. The authors concluded that "the prospects of diverting an attack from the

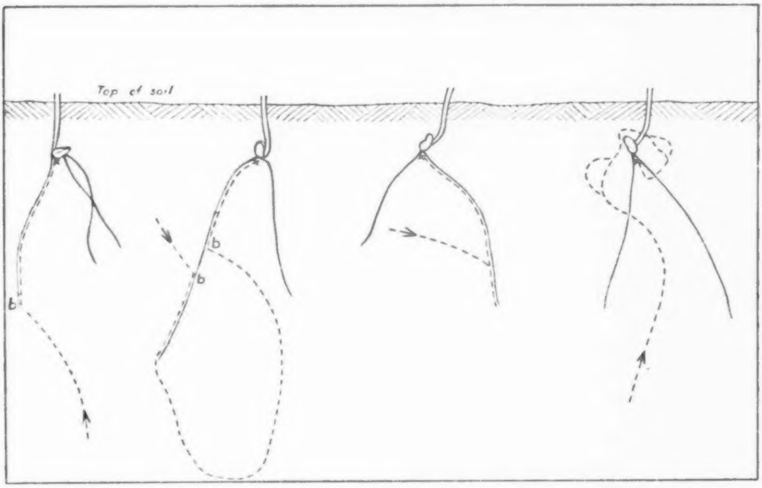

Fig. 1. Tracks made by wireworms in the region of germinating wheat. The arrows represent the position and direction in which individuals started, the crosses where they finished and began feeding on wheat grain. The letter *b* indicates points at which the root was bitten.

critical early stages of a crop are encouraging. The best time for this would presumably be before the wireworms have had the chance to establish burrow systems directly associated with the plants. The efficiency of any baiting method can, on the conclusions we have drawn from the work here described, readily be seen to depend greatly on the type and condition of the soil. To bring the bait method to its fullest practical efficiency in wireworm control the aim should be to produce a bait substance resistant to bacterial attack. This should then be mixed with a non-repellent contact poison. On these lines the method might have a wide application."

This work was continued and extended by Crombie and Darrah[12]. They found that certain compounds to which wireworms respond are secreted in small amounts by the roots of growing plants (Fig. 1) and that the root system of plants probably forms an extended trap along which the wireworms may be led to the grain or tuber in the centre, where a wound caused by their random biting would release active compounds in sufficient concentration for them to remain and feed.

Work on the biology and physiology of wireworms was also continued at Rothamsted by Evans[13]. The growth, feeding activity and moulting frequency of a population of wireworms were studied over a period of three years. It was shown that growth was strongly influenced by food; wheat and carrots permitted rapid growth, grass and clover slower growth, and on mustard and potatoes wireworms just maintained their weight; wireworms fed on flax actually lost weight. It was also shown in a field experiment that beans grown on a broken-up old pasture had the effect of reducing the population to a level at which a good crop of oats (28.5 cwt. per acre) was grown in the following year. In the same experiment, yields after grass and wheat were approximately 19 cwt. per acre, after sugar beet and barley 15 cwt., after flax 12 cwt., and after potatoes and oats 10 cwt. From observations made subsequently in other parts of the country it would appear that a bean crop does not always have such a marked effect on wireworm populations.

Field Studies Following the development of their large-scale washing apparatus, Ross, Stapley and Cockbill[14], in addition to examining many thousands of samples in the course of routine advisory work, investigated wireworm population changes on a field scale. Six grass fields were sampled intensively once a fortnight from July, 1943, to September, 1944: samples taken to depths of 12 and 24 inches showed that about 75 per cent of the wireworms were found in the top 6 inches but that a small proportion often occurred at depths below 1 foot.

The population changes after ploughing from grass and summer fallowing[15] were followed in six other fields. Only in two of these was there some reduction in the population in the first autumn and winter, and not until the first crop had been harvested was there a marked permanent reduction (30-70 per cent) in all the fields. This work was followed up in 1943 and 1944 by studying the population changes during a bare fallow[16] in no less than twenty-three fields. The results fully supported the views held by farmers that a bare fallow greatly reduces the numbers of wireworms and subsequent damage to crops. Populations were reduced in every case—sometimes to less than 10 per cent of the original level—wireworms of all sizes were affected, and almost all the smallest were killed (Fig. 2). The reduction was greater in fields ploughed in February and March than in fields ploughed in May. As a result of this work, therefore, it was possible to give further sound practical advice about cultural operations in relation to wireworm control.

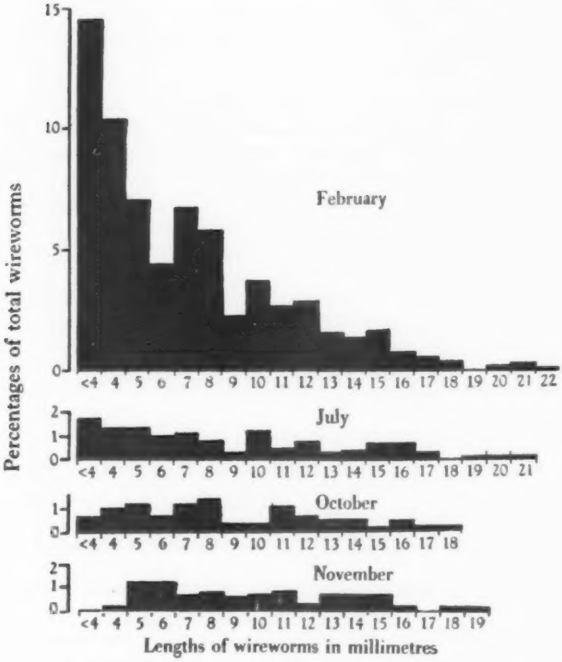

Fig. 2. Size distribution of wireworms from seven fallows taken together at four successive samplings, expressed as a percentage of the total number of wireworms found.

In their final contribution on wireworm populations in relation to crop production Ross, Stapley and Cockbill(17) compared the wireworm populations in failing and successful plots. They found that the wireworm-damaged areas did not in all cases have the higher populations ; they also found that the calcium carbonate content of the soil was consistently higher and the sand content consistently lower in the plots suffering most from wireworm damage. There was a suggestion, too, that wireworm attack commonly follows sainfoin. These workers refer to developments in chemical methods and conclude that the most effective use of a chemical treatment depends on reliable predictions about the probability of wireworm attack and that "it would be wrong to believe that the need has passed for field and laboratory studies which aim to provide a sounder basis for predicting wireworm damage".

Concurrently with the work on the wireworms themselves, studies of the adult click beetles have continued. There is always a possibility that a method of trapping and destroying the adults will be discovered, so that it is important to have a knowledge of their habits and preferences. At Rothamsted, Gough and Evans(18), and later Brian(19), studied the ecology of the more important species : for this work Brian developed a new electronic detection method for tracing movements of the click beetles in the soil. He also carried out extended trials with the large-scale Hollick extraction machine described above.

The behaviour of adult click beetles was also studied at the Midland Agricultural College where Roebuck, Broadbent and Redman(20) tried various methods of trapping and attracting the beetles. The most suitable trap

proved to be a 3-inch layer of hay placed over closely clipped grass. It was shown that maximum activity occurred in late May and early June during the afternoons and evenings.

Chemical Control The mosts triking advance in recent years towards solving the practical problem of controlling wireworms has undoubtedly been the discovery of the insecticidal properties of the chemical benzene hexachloride (BHC). Hitherto no satisfactory chemical means of dealing with wireworms has been known. Now all the older soil insecticides for the control of soil insects have been almost entirely superseded by DDT and BHC ; for the control of wireworms in particular, BHC is outstanding.

Following the discovery in 1942-43([21]) of the value of the gamma isomer of BHC (gammexane) as a powerful insecticide, workers at the Hawthorndale laboratories, Jealott's Hill, concentrated on its possible use for the control of wireworms, and in 1947 Jameson, Thomas and Woodward([22]) reported that BHC containing 13 per cent of the insecticidally active gamma isomer had been used successfully against wireworms in a number of large-scale field trials. There were three methods of application :

1. Broadcast—usually as a 2 per cent dust at 1½-6½ cwt. per acre ;
2. Combine drilled—usually as a 2 per cent dust at ¾-1½ cwt. per acre ;
3. As a seed dressing—(8 per cent gamma isomer) at 5 oz. per bushel of seed.

In general, the experiments showed that in conditions of heavy wireworm infestation of winter wheat and spring oats, twofold to fivefold increases in grain yield were obtained with the broadcast dressing, using 3 cwt. of a 2 per cent dust (=6 lb. of BHC per acre), and with the combine drill dressing, using 1 cwt. per acre of the same dust (=2 lb. of BHC per acre) : only slightly lower increases in yield were obtained with the seed dressing. In general, wireworm populations in these experiments were reduced to about one-third, one-half, and three-quarters respectively by the three treatments.

These results have been amply confirmed in numerous experiments in various parts of the country, and at Rothamsted in 1948 BHC as a seed dressing and broadcast was tested in trials which also included the soil fumigants, ethelyne dibromide and D-D. In addition to BHC, the ethelyne dibromide treatment appeared to be particularly promising, and it remains to be seen whether the effect of these insecticides has been carried over into the 1949 crops. Particular attention will also be paid this year to the question of tainting of subsequent crops. BHC insecticides are, unfortunately, not without their disadvantages, and at present they are not recommended for use on soils to be cropped in the same year or either of the two following years with potatoes, onions, carrots and other root vegetables for human consumption, because there is a risk that flavour may be affected. Nevertheless, up to the present, BHC insecticides represent a very great advance in the use of chemicals for the control of wireworms.

Team Work Wireworms have always been regarded as the chief insect pests of agricultural crops in this country, and entomologists have given much thought and time over a long period of years to the problem of their control. In 1938-39 this work was intensified and the Agricultural Research Council set up a Conference to co-ordinate and initiate further work. The contributions described in this paper are the results of much patient investigation by research workers at universities, Government research stations, the research stations of commercial firms, and by advisory entomologists ; farmers themselves have also contributed in no small measure by their generosity and willingness to lend their fields and crops at all times. Now that a chemical control measure is available, a milestone in

wireworm research has been reached, but the aim must always be prevention of attack. Farmers must not on any account sit back and call for help when the damage has been done ; rotations must be carefully considered, and cultural methods for reducing populations combined with the chemical methods where damage is likely to occur. Occasionally, detailed knowledge of the local conditions and the geographical location of a field are enough in themselves to enable an experienced adviser to say whether a particular field is likely to have a high wireworm population, but probably the field will need to be sampled ; if a high population is found further advice will depend on the particular circumstances, e.g., (*a*) the field may be best left unploughed ; (*b*) the rotation may be modified ; (*c*) a bare fallow—ploughed early—may be advocated ; (*d*) the rotation may not be modified, but treatment with BHC may be advocated ; or (*e*) a combination of modified cultural operations, modified cropping and chemical treatment may be advised. It will be seen, therefore, that advisory officers are now in a stronger position than hitherto to advise on wireworm problems. The help of District Officers and Advisory Entomologists should be sought before ploughing up old grassland, especially those fields known to have a "wireworm history".

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FARM GRAIN STORAGE

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MORE and more grain is being cut with combine harvesters. At least 7,500 machines will be at work this year, and by 1950 it is estimated that the number will have risen to 11,000. Bulk storage to hold some of this grain is being installed by merchants; it is, however, becoming more than ever necessary for farmers to install equipment capable of storing at least part of the combined cereals.

In such circumstances it is essential that the grain should be in a fit condition for storage. It should be reasonably clean and free from greenstuff, and the moisture content should be reduced to 15-16 per cent ; provided elementary precautions are taken, at this figure the grain may be stored satisfactorily under farm conditions up to six months. Good keeping depends just as much on the condition of the grain as on the type of container used to hold it.

Storage in Sacks The sack is a very efficient container for combined grain that is not too damp, provided precautions are taken to prevent moisture rising from the floor through the bottom of the sack. An upper floor is best for storage ; if, however, the ground floor has to be used, a temporary, wooden slatted floor, to prevent rising damp and to allow air circulation under the sacks, will help to keep the grain in the lower part of the sack in good condition. Storage in sacks can prove costly if it is used for long periods, owing to the expense of hire or purchase of the sacks and the risk of damage by vermin. Handling costs are more expensive than with bin storage and power conveying ; grain may however be stored in a sack at a slightly higher moisture content than in a bin.

Pre-cast Concrete Bins One type of bin commonly used is of circular form, constructed of pre-cast concrete slabs. This is available in ten sizes, ranging in diameter from 8 feet 1 inch to 15 feet 1 inch, and can be erected to any convenient height up to 20 feet. The bins are built up from ground level with pre-cast tongued-and-grooved concrete staves, the internal pressure being taken by adjustable steel wires or rods placed horizontally round the outside of the bin.

These bins, which at the moment are in good supply, provide a cheap form of container and can be erected with the minimum of skilled workers; much, if not all, of the work can be done by farm labour. They also have the advantage of being easily dismantled and re-erected. The use of circular bins in square or rectangular buildings can lead to a serious waste of the available floor space. The bins are fireproof, but the outside surface must be specially treated to make it weatherproof.

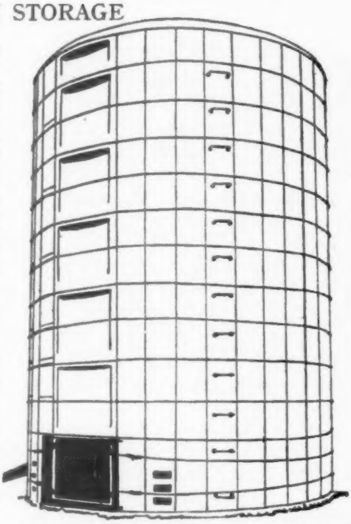

Fig. 1. Circular bin constructed from pre-cast concrete staves. Note inverted louvres near bottom.

Another type of concrete bin may also be constructed from hollow pre-cast sections. The bins are square and are formed by building up successive layers of the sections, which have *cranked* ends to provide a space in which is cast, *in situ*, a column of reinforced concrete. The units are made to form a standard 10 feet square bin. The method of construction allows any number of bins to be built together and carried up to suit the height of the eaves of the building. A self-emptying hopper bottom may be fitted if desired. The bins are weather- and vermin-proof, and require no maintenance.

Brick Bins A satisfactory type of bin may be constructed from bricks laid in cement. All the walls will need to be in 9-inch work, with the partitions and external corners bonded for maximum strength; additional strength at these points may be obtained by building into the brickwork suitably shaped iron tie rods. Under a height of 10 feet, for bins of up to 25 tons capacity, it should not be necessary to use internal iron cross tie rods. If Flemish bond is used the wall can be reinforced by building in at convenient intervals a series of ⅜-inch diameter steel tie rods placed vertically; additional strength may be obtained by bedding the lower ends of the rods into the concrete floor. If the bins are over 10 feet high, they should be cross tied in both directions by metal rods, with substantial plates on the outer surface of the walls. To prevent rising damp it is advisable to insert a damp course near ground level. This type of bin is fireproof and

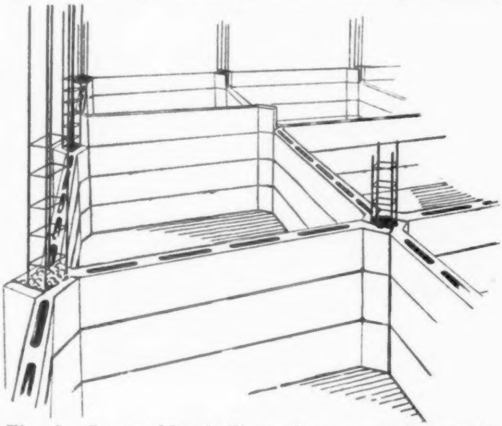

Fig. 2. Square bins built up from pre-cast concrete sections. Note reinforcement at angles.

can be constructed from readily obtainable materials. Skilled labour is needed for its erection, and once put up it cannot be dismantled and re-erected.

Wooden Bins Wood is one of the most suitable materials for the interior surface of a grain storage bin. A common method of constructing square or rectangular bins is by building the walls up from floor level by nailing successive lengths of wood, 2 inches × 2 inches or 3 inches × 2 inches laid flat, into each other. The external corners should be tied by running alternate lengths through to the outside; partitions can be tied to the outer walls in the same way. As the walls are being built up over the whole lay-out, care should be taken to keep them straight and vertical; this can best be achieved by erecting a number of temporary vertical members, against which each layer is placed before nailing down. Any ties or ladder rungs in the internal angles should be built in as construction proceeds.

An advantage of this method of construction is that the walls are thin and the bins may be made to fit closely into any available space, together with the fact that much of the constructional work can be carried out by unskilled labour. These bins are not fireproof and they cannot easily be dismantled for erection elsewhere. At the present time timber is both expensive and scarce.

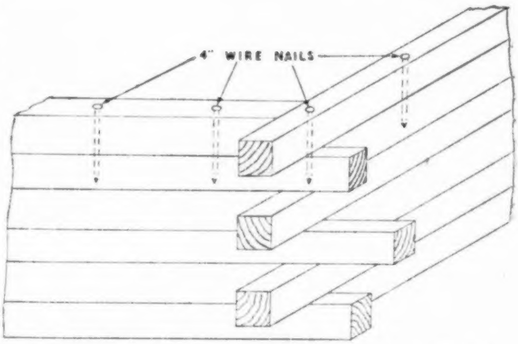

Fig. 3. Corner of bin constructed from 2" × 2" wood.

Another type of bin constructed mainly of wood can be made by building up timbers on edge between H section steel stanchions. The timbers, which are put in from the top, must be cut just long enough to drop in the vertical grooves formed by the stanchions. The external corners of the bins are formed by the erection of two adjacent H section members arranged to provide grooves at right angles. The thickness of the timber should be related to the length of carry, which is determined by the distance between the stanchions. As the timbers do not hold the bin together, the outward thrust must be taken by tying in the vertical members across the top of the bin.

Ventilated Bins Grain may be ventilated in the bin by making provision for a current of air to pass up through the mass of grain. This type of bin may be divided into two classes: those which rely on natural air currents for ventilation, and those where forced ventilation is carried out by means of a fan.*

For natural ventilation the air may enter through suitably shaped openings in the walls of the bin; these may be either near the ground or all the way up the sides of the bin. In some cases the openings take the form of a series of inverted louvres built into the lower parts of the walls, thus permitting the entry of air without allowing the grain to run out. Another type

*R. A. Vinter. Storage Drying of Grain. *Agriculture* (February, 1949), 488.

of bin which makes provision for natural ventilation throughout the height of the walls, is constructed from concrete beams 9 inches deep ; the beams are truncated cone shape in section. Each side of the bin is formed by successive horizontal layers of the beams, which are erected with a ½-inch air space between them. Each beam is placed with the thicker edge at the bottom, thus providing an overhang to the beam below ; although a space exists between the beams, the angle of repose of the grain from the lower overhanging edges does not allow grain to escape.

In some cases additional ventilation is provided by building in across the bins a series of hollow triangular ducts, thus allowing air to circulate through the bin in contact with the grain. If possible, it is an advantage to place these ducts in the direction of the prevailing wind. Experiments carried out in this country and the U.S.A. together with a study of the principle involved, tends to throw considerable doubt on the effectiveness of this method of ventilation.

Forced ventilation is carried out by blowing a current of air into the lower part of the bin and allowing it to pass up through the column of grain. This method can be used successfully to prevent or reduce heating of the grain in the bin. Within the limits set by the relative humidity of the air used for ventilation, it will also provide a means of slowly drying the grain in shallow layers ; it cannot, however, be regarded as a satisfactory substitute for a grain drier in the higher rainfall districts. A well-designed system of ventilated bins will provide storage and facilities for limited drying for the smaller farmer in those areas where part of the crop may be gathered at a moisture content slightly above the safe storage limit.

If provision is made to ventilate grain in the bins it will inevitably add to the cost of storage installation. The walls and bottoms of the bins must be airtight, a horizontal false floor which will hold grain and yet permit air to pass through must be provided, while a suitable fan and motor, together with the necessary ducting, will be needed.

It is possible to install a heater to raise the temperature of the air slightly before it is passed through the grain. This will allow ventilation to be carried out irrespective of weather conditions ; it will, however, increase the cost and tends to complicate management, but where ventilation is provided for, some provision for heating the air might well be considered.

Bin Floors At some stage it will be necessary to decide whether the bins are to have a sloping or horizontal floor, i.e., self-emptying or otherwise. The self-emptying bin will save a certain amount of labour ; but it reduces storage capacity considerably. If a self-emptying bottom, sloping at 45 degrees, is built into a bin 15 feet high and 10 feet in diameter, its capacity is reduced by one-third ; the percentage reduction in capacity is greatest in the larger diameter bins of low height. Where bins are raised above ground level, the disadvantages of self-emptying are not so great, since it is usually possible to slope the floor to a central discharge point.

To avoid the loss of storage capacity, a compromise can be made with bins at ground level by constructing the floor with a slope of 15 degrees towards the discharge point. In most cases farm storage installations call only for the occasional discharge of bins ; when this is being carried out there is usually a man in attendance who can keep the grain running and finally sweep the bin out.

Conveyor Systems Some means must be provided for moving the grain to and from any part of the storage system. Provision must be made for passing the grain from the wet pit to the drier or

dresser before it is placed in the storage bins. A sacking-off point will be needed to allow grain to be sacked off from the bins either direct or through the dresser. The installation of the conveying equipment is a specialist job. Before any work on the building or storage bins is started, it is desirable to seek the advice of the firm who will provide and fix the equipment. Two distinct types of conveying equipment are commonly used in farm grain storage installations—mechanical and pneumatic. Each has its advantages and disadvantages. In many instances a satisfactory compromise has been reached by using a mechanical elevator for the short vertical lift and the pneumatic conveyor for the longer and mainly horizontal distances.

Mechanical Conveyors and Elevators With this type the grain is moved by means of a worm or an endless belt carrying cups, rings or slats, and running in a wooden trunk or steel duct. This method is best suited for the shorter distances, especially the vertical lift ; for example, from the wet grain pit to the drier or dresser. For a similar conveying rate and distance, the power required for this method is lower than that needed for a pneumatic conveyor. Care must be exercised when changing from one type of grain to another, as this system is not self-cleaning. The grain is moved in a mass, as distinct from the pneumatic type, which provides a greater degree of separation during conveying.

Pneumatic Conveyors The grain is conveyed by a high velocity air stream inside a steel duct 6 to 9 inches in diameter. The air stream is supplied by a suitable fan designed to match the conveying rate, the size of the duct and conveying distance. The fan is best driven by an electric motor, but an internal combustion engine may be used if mains current is not available.

The pneumatic conveyor allows a degree of flexibility which can be varied to suit the size of the installation. For the larger installations the motors, fans and ducting would be fixed permanently ; for the smaller installation the motor, fan injector and ducting may be portable, the power unit being moved and the ducting arranged to suit the conveyance required. In some cases a compromise is made by having certain sections of ducting permanently fixed while the portable power unit fan and injector is coupled to them as required by suitable lengths of duct. When this method is adopted it is possible to use lengths of flexible rubber duct which can be coupled to the rigid metal sections. To avoid damaging the grain the minimum number of bends should be used, while care should be taken to inject grain at the correct conveying rate. To lower the velocity of the grain when discharging into a bin, reducers should be fitted to the discharge ends ; care should also be taken to avoid discharging the grain against the side of a bin. The pneumatic conveyor has only one moving part—the fan—the whole system being practically trouble-free in operation. When injection ceases the system is self-cleaning—a great advantage when frequent changes are made.

Lay-out In almost every case, a bulk storage installation will consist of :

1. A building to house the installation.
2. A receiving hopper or pit.
3. A grain drier or dresser and pre-cleaner.
4. Bins to hold the grain.
5. A conveying system to move the grain.
6. A power unit or units to drive the conveying mechanism.
7. A point where the grain can be sacked off.
8. Sack storage space.

The lay-out of the installation should permit speedy discharge from vehicles bringing in grain; the wet grain pit should be sited to allow vehicles to draw over or pass it without turning or backing; the capacity of the pit should be matched to the size of the combine and the type of vehicle used for transporting grain and the throughput of the conveying system. Water is often troublesome when an excavation is made for the pit. Temporary methods are seldom successful and often prove the most costly in the long run. If water is present adequate steps should be taken to keep it out; this can best be achieved by a lining of two ⅜-inch thick layers of asphalt.

The number of bins installed will depend on the total capacity and the type of building. A large number of small bins is preferable to a small number of large bins; if the latter is unavoidable, greater flexibility can be obtained by partitioning large bins.

Arrangements must be made for conveying the grain from the receiving pit to the drier or dresser and thence to the storage bins. From time to time it will be necessary to turn over the grain and to bring it from the bin for sacking. The sacking-off point should be as close as possible to the sack storage space and the loading platform, which, if possible, should be raised.

A power-driven pre-cleaner and dresser are an integral part of a bulk grain storage installation. It should be large enough for the size of the installation, preferably with a throughput of not less than 2 tons per hour. If the dresser can be raised sufficiently, the sacking-off point can be placed immediately below it. Given sufficient height, it is an advantage to provide a hopper between the outlet from the dresser and the sacking-off spouts. This reservoir will provide flexibility and possibly reduce the labour required for sacking-up grain.

LOSSES AND GAINS OF AGRICULTURAL LAND IN ENGLAND AND WALES

THE extent to which a more or less limited total area of agricultural land is being depleted from year to year by the inroads of building development, the needs of the Service Departments, and so on, has aroused a good deal of attention. This article is concerned with the statistical basis for estimating the extent of those losses. It is commonly assumed that the Ministry, which obtains returns of crops and grass from occupiers and publishes annually the total area of these and of rough grazings, must be in a position to state the year-to-year changes accurately. Such estimates have indeed appeared in the Reports of the Barlow Commission and Scott Committee, and have been quoted in Parliamentary Debates; and they have also been accompanied by estimates of agricultural land lost to particular alternative uses, such as housing.

Actually the accurate estimation of the amount of land lost to agriculture is a difficult matter, not only in England and Wales, but in any country of the world. In this country the areas recorded do not cover all the land which could reasonably be regarded as agricultural, and the area not included is capable of varying so much as to obscure the year-to-year changes in the part covered by the annual returns.

It may be of some interest to outline the main reasons for the omission of some part of the total agricultural area.

Scope of Official Statistics First, the statistics have as their main object the estimation of crop and livestock production : to account for the total agricultural area is only a secondary purpose. Thus these statistics have not hitherto extended to estimating that part of the area of agricultural holdings which consists neither of arable crops nor of permanent grass and rough grazing land. That is to say, the Ministry's returns do not cover the area of copses, spinneys and shelter belts ; of land occupied by farmhouse and farm buildings ; that under farm roads and yards ; ponds ; the occupier's flower garden or lawns ; patches of land not used for any agricultural purposes. For some of these items, statistical inquiries from occupiers would not be covered by existing statutory powers which relate to land " used for agriculture " in a strict legal sense.

On the other hand, returns of land taken from agriculture by other Departments, such as the Ministry of Transport, would no doubt include these non-agricultural areas, and for this reason would fail to agree with the Agricultural Department's estimate of loss for the same land.

Secondly, the statistics of acreages have not, during the past fifty years, covered pieces of agricultural land of one acre or less. Thirdly, they do not, for obvious reasons, cover land which for one reason or another is not at the time known to the officer collecting the returns to be used for agricultural purposes, though this area is believed to be much smaller now than formerly.

Whether or not the sum total of the excluded areas is statistically significant depends on the use to be made of the statistics. There is no reason to think that their inclusion would exert any appreciable effect on the Department's estimates of crop or livestock production. Nevertheless in the particular context of annual changes in the total agricultural area these matters are important for the reason that the non-included areas may fluctuate considerably from year to year.

The leading instance under this head was the addition to the returns of some 250,000 acres in 1941, the year in which feedingstuffs rationing was introduced. Many occupiers of holdings who were not furnishing returns because they were not on the collector's list of addresses then found it desirable to draw the attention of the Ministry's officer to the omission and to ask for forms of return to be sent to them. Similar but smaller changes also affected 1942 and 1943. It is evident that changes of the magnitude of 250,000 acres in a year are capable of masking the true change in the area of agricultural land, and in fact in 1940-41 converted a probable true loss into an apparent gain.

For all these reasons the year-to-year changes in the total area recorded by the Ministry's returns can be taken only as a very rough guide to the net annual loss of agricultural land in any given year and, on occasion, may even be misleading. Averages covering a series of years will smooth out minor fluctuations but will do no more than minimize the effect of a major fluctuation such as occurred in 1941.

Tracing Changes in Land Use It is necessary, therefore, to investigate as far as possible the reasons for the various changes of acreage, but other points of difficulty then arise. These derive from the fact that every year there are no fewer than 80,000 holdings which show changes in acreage. To trace the reasons for all these changes would involve a great deal of labour, even if there were no difficulty in discovering the facts on first inquiry ; but, in addition, the reasons for the change may by no means be immediately apparent.

LOSSES AND GAINS OF AGRICULTURAL LAND

When returns fail to arrive from any occupier on the list the local officer responsible for the collection of the returns makes inquiries to see whether the land has changed hands and has ceased to be used for agricultural purposes. In the latter event the local officer is expected to do his best to ascertain how the land is to be used in future. Similar inquiries have to be made when the acreage returned by any occupier is reduced. By summarizing the explanations obtained in this way, it is possible to arrive at some approximate indications of the gross losses of agricultural land in the course of the year and the main reasons for those losses.

There are, however, " gains " every year which must be set against these losses. Not only is land returned from the Service Departments to agricultural use—in which case the change usually comes to notice immediately—but derelict land may be reclaimed, or land previously taken for building development may be brought back into agricultural use. It is physically impossible for the Ministry's officers to keep track of all such land returning to agriculture, and often it is only after the land has been in agricultural use for some years that the occupier is asked to make a return. In these circumstances it would involve a disproportionate expenditure of time and labour to link up the new return with the earlier deletion, and commonly it has sufficed that an explanation "not returned last year" has been accepted. On the "gains" side, therefore, there is an element of uncertainty in respect of a not inconsiderable proportion of the total, and the gains cannot be matched against the corresponding losses. Thus during 1939-40 to 1944-45 the recorded average loss to building was 24,300 acres annually, and recoveries from building 9,100 acres annually. The latter figure, however, is certainly a considerable underestimate ; much of the recovery under the heading "previous use uncertain" (other than land previously escaping enumeration) is undoubtedly due to the return to agricultural use of land taken for building development some years previously, and not built on.

Estimates of Land lost and gained since 1927

The following Table presents the available data, subject to the reservations discussed above.

Losses and Gains of Agricultural Land in England and Wales

	AVERAGE OF 12 YEARS 1927-28 TO 1938-39	AVERAGE OF 6 YEARS 1939-40 TO 1944-45	AVERAGE OF 3 YEARS 1945-46 TO 1947-48
I. GROSS LOSSES	*thousand acres*	*thousand acres*	*thousand acres*
Building Development	47.5	24.3	38.6
Allotments	2.5	3.7	2.4
Sports Grounds	11.0	3.7	9.7
Waste	7.2	5.9	1.6
Woodlands	18.6	18.9	10.1
Forestry Commission	—	6.1	8.7
Governments Departments	8.8	123.6	14.0
TOTAL	95.6	186.2	85.1
II. RECOVERIES			
Building (sites vacated)	17.1	9.1	2.6
Allotments		1.3	.5
Sports Grounds		8.2	1.0
Waste		11.5	1.8
Woodland		3.9	3.0
Forestry Commission		2.2	1.4
Government Departments		22.2	63.7
TOTAL	17.1	58.4	74.0
Previous use uncertain	14.8	71.1	13.7
Grand Total	31.9	129.5	87.7

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	Average of 12 Years 1927-28 to 1938-39 *thousand acres*	Average of 6 Years 1939-40 to 1944-45 *thousand acres*	Average of 3 Years 1945-46 to 1947-48 *thousand acres*
III. Net change in the agricultural area of crops, grass and rough grazing in sole occupation, i.e., difference between I and II (increase + decrease —)	—63.7	—56.7	+ 2.6

In the twelve years prior to the war there was an average annual gross loss of rather less than 100,000 acres, of which approximately one half was reported as being intended for building development. Recoveries averaged 32,000 acres, and the net decrease in the area covered by the agricultural returns (excluding rough land grazed in common) was about 64,000 acres. In those years the local officers were not required to attempt to ascertain the previous use of land reverting to agricultural use, beyond reporting where it was not so used in the preceding year. During the six years ended 1944-45 the gross losses practically doubled, mainly by reason of the large demands of the Service Departments for airfields, training grounds, etc. Recoveries also increased, and the remarkably high figure of 71,000 acres under the heading " previous use uncertain " was due in large part to the operation of war-time controls and measures such as the feedingstuffs rationing scheme already referred to ; the increase in the average rate of recovery represents not so much new areas brought into agriculture as the recording of agricultural land that had previously escaped enumeration. On balance, however, recoveries were still less than gross losses, and over the six years the average decrease in the recorded agricultural area was approximately 57,000 acres.

During the past three years annual gross losses have dropped by over 100,000 acres from the war-time average, and the Table shows clearly that this is the result of diminished demands by Government Departments generally. The area of land intended for building development as well as for sports grounds has increased again, but these increases have been offset in other directions. The annual rate of loss, apart from requirements of the Forestry Commission and Government Departments, has been less than in the pre-war period. Recoveries have also fallen away in total because of a return to normality under the heading " previous use uncertain," although recoveries from known sources increased because of the release of land by Government Departments. On balance, there was a trifling increase in the agricultural area.

FOUL BROOD DISEASE OF BEES ORDER, 1942

SUMMARY REPORT, 1948

FOR the fifth successive year the returns from the County Agricultural Executive Committees in England and Wales show an increase in the number of apiaries and colonies of bees inspected by Appointed Officers under the Foul Brood Disease of Bees Order, 1942. 14,500 apiaries, containing a total of 61,600 colonies, were examined during 1948. Foul Brood was found in 940 apiaries and 1,880 colonies ; it was also found in three "wild" colonies. Two beekeepers were prosecuted for failing to comply with notices, served under the Order, to destroy infected colonies.

FOUL BROOD DISEASE OF BEES ORDER, 1942

The position in 1948 in relation to 1944-47 for England and Wales as a whole was as follows :

	1944	1945	1946	1947	1948
Apiaries visited	6,600	9,300	10,900	12,400	14,500
No. in which Foul Brood was found :					
American F.B.	995	930	795	845	919
European F.B.	20	11	24	43	21
TOTAL	1,015	941	819	888	940
PERCENTAGE OF INFECTED APIARIES ..	15.4	10.1	7.5	7.2	6.5
Colonies examined	26,500	35,200	45,200	52,000	61,600
No. in which Foul Brood was found :					
American F.B.	1,802	1,602	1,357	1,361	1,840
European F.B.	43	30	52	145	40
TOTAL	1,845	1,632	1,409	1,506	1,880
PERCENTAGE OF INFECTED COLONIES ..	6.9	4.6	3.1	2.9	3.0

The number of Appointed Officers engaged during 1948 in the work of carrying out inspections under the Order was 588. This total consists largely of beekeepers who have volunteered for local duties in their spare time, but a number of officers have now been appointed to work on a full-time basis for the period of the active beekeeping season. The desirability of retaining an adequate panel of experienced beekeepers for local work has, however, been stressed whenever proposals for the appointment of full-time officers have been put forward, since experience has shown that the part-time worker with a good knowledge of local conditions makes an important contribution to the smooth working of the county organization. The inspection of over 60,000 colonies, or about one-seventh of the total number of colonies in England and Wales, in one season is a very creditable demonstration of the interest in the campaign against Foul Brood which has been aroused among beekeepers since the introduction of the Order.

American Foul Brood The increase in the scale of inspections in 1948 was accompanied by an increase in the number of apiaries in which American Foul Brood was discovered—919 as against 845 in 1947. An intensification of the search for Foul Brood in Gloucestershire and Kent followed the appointment in these two counties of full-time County Beekeeping Instructors, who were seconded to their respective Agricultural Executive Committees for work under the Order. Many outbreaks of American Foul Brood came to light, involving 468 colonies—241 in Gloucestershire and 227 in Kent, compared with 3 and 18 respectively in 1947. In addition, numbers of derelict hives containing diseased combs were found. The outbreaks in these two counties account almost entirely for the increase in the number of cases of American Foul Brood recorded during the year ; in both Gloucestershire and Kent, however, relatively little had been done in previous years to control Foul Brood. In some other counties the scale of inspections has been maintained at a consistently high level for the past three, four, or five years ; and it is in these counties,* which altogether contain approximately 45 per cent of the total number of colonies in England and Wales, that the most consistent efforts have been made to check the spread of the disease. The incidence of Foul Brood per 100 colonies examined, calculated year by year for the combined territory represented by these active counties, is as follows :

1944	1945	1946	1947	1948
7.1	4.3	2.9	2.7	2.1

* Bedfordshire, Berkshire, Buckinghamshire, Cardiganshire, Cornwall, Cumberland, Devon, Dorset, Essex, Hampshire, Middlesex, Norfolk, Somerset, Surrey, Warwickshire, Wiltshire, Yorkshire (North Riding) and Yorkshire (West Riding).

These figures give the clearest available indication of the cumulative effect of a persistent policy of eliminating Foul Brood wherever it is found, combined with regular inspections and follow-up visits in the infected areas. Any slackening of effort now would very soon undo the good work that has been done in the past, and it is hoped that in counties such as Gloucestershire and Kent which have only recently made a real effort to tackle the disease systematically—and in others where the effort has yet to be made—the campaign will be stimulated by a realization of what has been achieved elsewhere.

European Foul Brood The number of cases of European Foul Brood reached a peak in 1947 (145 colonies in 43 apiaries) following the 1946 outbreak in Wiltshire,* but in 1948 only 40 cases in 21 apiaries were reported. These included four cases in one locality of Essex—the first recorded in this county: one was discovered in a colony established from a stray swarm; further search led to the discovery of two more cases, and finally to the fourth in the apiary of a beekeeper who brought two colonies from the infected source in Wiltshire in 1946. There is no evidence of any large-scale spread of European Foul Brood as a result of the 1946 outbreak, despite the large number of colonies which were sold to various parts of the country, though the extent to which infection may have spread in the neighbourhood of the apiary sites in Wiltshire previously occupied by the diseased bees has not yet been fully investigated.

Sulphonamide Treatment Since the previous report was published on the use of sulphonamides against American Foul Brood,† further trials have been carried out on colonies selected for special treatment. Three methods of giving the drug to infected colonies have now been tried:

(1) Feeding syrup containing the drug without removal of any of the diseased brood or contaminated honey;
(2) Feeding syrup containing the drug following the transfer of the bees to clean comb foundation in a clean hive, all the brood and combs being destroyed by fire; and
(3) Spraying the combs with a solution of the drug in alcohol.

The first method, though effective in most of the trials where it was applied, failed to clean up the disease in two instances, even after prolonged treatment extending over several months, and in two of the colonies which were apparently treated effectively in 1946 a recurrence of the disease was reported—in one case later in the same year, and in the other case in 1948. Similar recurrences have frequently been reported from America following the application of this method. The well-known "shaking" method, of which method (2) is a modification, has always been regarded as a difficult operation requiring great care if the spread of disease is to be avoided. Experience in this series of trials has confirmed this view; two of the trials had to be abandoned because the bees swarmed out of their new hives shortly after the shaking and were lost. Method (3), applied to two trial colonies in 1948, eliminated all visible signs of disease after three sprayings during a period of six weeks; these colonies will be kept under observation in 1949. Here again, however, the combs must be shaken to free them from bees before spraying, and there would be a risk of robbing if the operation were carried out carelessly, especially if done late in the season after the main nectar flow.

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* Summary Report, 1946-47. *Agriculture* (May, 1948), 88.

† MILNE, P. S. Sulphonamide Treatment of American Foul Brood. *Agriculture* (May, 1947), 82.

None of these methods can, therefore, be regarded as a safe alternative to burning the bees and combs. Also, it is now known that sulphonamides have no beneficial effect on *European* Foul Brood. Consequently, the policy of destroying all cases of Foul Brood (American or European) dealt with under the Order is being maintained. The destruction extends, however, only to those colonies in which the presence of Foul Brood is confirmed following a laboratory examination of a sample comb ; healthy colonies in the same apiary are not subject to destruction. No compensation is payable from official sources for colonies destroyed, but beekeepers are reminded that many beekeepers' associations can offer compensation to their members either through the scheme operated by Bee Diseases Insurance, Ltd.* or from funds available within the local or county organization.

FARMING AFFAIRS

Linseed Harvesting, 1948 : West Riding Experience Success in linseed harvesting depends largely on the uniformity of the crop ; it is therefore essential to prepare a fine, firm seedbed and to drill the seed evenly and early, using one of the newer varieties such as Redwing, Royal or Bison, which ripen more evenly and the seed heads of which do not shatter.

Our experience with linseed in the West Riding last year proved that, provided the cutter-bar is in good condition, with the knife and ledger plates sharp, and with the clips and wearing plates adjusted correctly, the binder will deal with linseed quite satisfactorily. In most cases ground-wheel drive binders have been used, but it is, of course, preferable to use a power-driven machine, because under difficult conditions the forward speed of the binder may then be lowered without changing knife speed.

It is important that the binder should be set to tie as small a sheaf as possible, since it permits easier separation when the sheaves are ejected from the binder. Further, small sheaves dry out more easily, and to assist drying still further the sheaves should be set up only four per stook.

It has been found that the plain section knife is more efficient than the serrated-edge knife, provided it is kept very sharp. The serrated knife does not give a clean cut, and consequently breaks the fibre, which in turn causes the knife to jam, particularly if there is any wear or play on the cutter-bar.

Linseed has been cut with a mower in a few instances, and as the knife speed on a mower is higher than a binder, cutting presents little or no difficulty ; but it is essential that the cut crop should not be run over, since the slightest pressure will cause shelling. One way of overcoming this difficulty is to fit two swath-boards to the mower.

Direct combining of linseed should not be generally adopted, as it is rarely easy and has the following disadvantages : (1) Loss of chaff which is good feed ; (2) Loss of seed may be heavy ; and (3) Difficulties in drying the seed.

Some growers have found that the knife speed is not fast enough on combines, and this has led to innumerable stoppages ; one farmer I know had to abandon combining and cut with a mower. Linseed may be combined direct or from the windrow ; opinions are generally divided as to which is the better method, but each has its advantages. One of the chief advantages of

* C. P. Abbott. The Story of Bee Diseases Insurance. *Agriculture* (April, 1949), 21.

direct combining is the saving in labour. On the other hand, windrowing is useful sometimes to dry out weeds in a ripe crop. Apart from specially designed windrowers, the binder can be used with part of the tying mechanism removed. This method puts the crop into a uniform row well clear of the tractor next time round. The linseed should feed into the drum evenly from the windrow ; it is therefore essential to have an efficient pick-up attachment fitted.

To sum up, the method to be recommended for harvesting linseed is to cut with a binder, stook, stack and thresh with a standard machine. A combine harvester in the hands of an experienced operator may do a fair job, but is not generally recommended.

G. Crabtree.

Nature Month by Month—August We have reached the crown of the year, and summer has noticeably waned. The corn harvest is under way, and many and various will be the creatures that bolt from sanctuary in the "last bit". Reaping has laid bare the stale secrets of bird and beast and insect ; the empty waxen shells of a bumble-bee's nest in an old mouse-hole ; the bigger hole where, unsuspected in the spring, a litter of weasels was born and reared ; the abandoned nest of a skylark from which the young have long since gone.

In the woods the tits are flocking, some in family parties and some in mixed gatherings of two or three species. One sees them travelling from tree to tree, vociferous and busy in their search for insects. It is good to find the dainty long-tailed tits in something like their old numbers ; they seem to have recovered from the great blizzard of three years back.

The adult cuckoos have gone overseas, but the young birds will be with us for a month or two longer. One remembers, as recently as last month, the shrill, querulous voice of a young cuckoo in the nest of a pair of small birds whose long day was occupied in feeding their insatiable foster-child. It is no wonder that the death-rate among young cuckoos is so high. Never was there a noisier young bird, nor one that so persistently advertised its presence to the world of predators. Bird song is almost wholly absent, now. Yesterday, the only bird that I heard singing was a yellowhammer, complaining, as always, that his "little bit of bread" had "no cheese".

There is more water in the river, now. A week or two ago, before the rain came, there were a dozen big peal in the pool below the weir, waiting for a friendly freshet. All have gone on. The other day I found a three-pounder, dead upon the bank, that had fallen prey to an otter, which in the way of otters had taken a bite or two from the fish's back near the head and left the rest. I have never known an otter to return to a kill. In the shallow reach above the weir there stands a heron, stiff and motionless, seemingly asleep but very wide awake, bill down, eyes steady on the rippling water.

Up on the Moor, in bare, stony places, adders bask in the sun. There are more of them, I think, than I have seen in any other year. Also, every big, sun-baked stone seems to have its lizard, beady-eyed and watchful, ready in spite of its apparent lethargy to move like lightning if danger should threaten.

This month the heather will be in bloom, and then we shall have sunsets the like of which are hard to find elsewhere. Often, in late summer, I have watched the sun go down beyond the Moor, when all the world seemed filled with a purple glow.

F.H.L.

Increase in Pig Rations : Further Details Below are given further particulars of the increased rations for commercial pig production announced by the Minister of Agriculture and Fisheries on May 19. (See p. 130 of the June issue of this JOURNAL.)

1. *Bonus Rations.* With the period commencing September 1 the rate is increased to 3 cwt. per 160 lb. (8 score) of pigmeat delivered to slaughter-houses and bacon factories in the previous four months. Producers who obtain regular rations for pigs from their County Agricultural Executive Committees will receive a bonus application form from their Committee in due course. Others can obtain these forms on application to their Committee.

2. *Farrowing Sow Allowance.* The rate is increased from 8 cwt to 9 cwt. for eligible sows due to farrow on or after July 1, 1949. From September 1, 1949 the allowance will consist of 3 cwt. of a new National Pig Starter food, with the remaining 6 cwt. in ordinary cereal and protein. This new Pig Starter food has been specially designed to provide for the needs of young pigs and contains a higher minimum proportion of protein than existing pig foods. Producers will get information on the best method of using the food and when sending in their application forms will have an opportunity, if they prefer, to ask for the whole 9 cwt. in ordinary cereal and protein coupons.

3. *Basic Issues.* For the period September to December, 1949, as an interim measure, basic rations for *pigs* will be given for up to 22½ per cent (9/40ths) of the basic registered pig numbers, at the rate of 1 cwt. per pig per month, after making the present acreage deduction of 1 cwt. per 64 acres of the holding. The increase in the ration given to occupiers of combined "pig and poultry holdings" will be provisional, as a possible method of bringing the rations for these holdings into line with present stock numbers is under discussion. Occupiers of such holdings must not assume, therefore, that after the end of 1949 they will continue to get exactly the same increase as for the period September-December, 1949. Poultry rations will be at the winter rate of 1 cwt. for 20 birds per month for one-fifth of the registered numbers, less the usual acreage deduction.

4. *Extended Scheme.* From September 1, 1949, the new specified numbers for pigs for which rations can be allowed are as follows :

ACREAGE OF HOLDING (excluding rough grazing)	SPECIFIED NUMBERS OF PIGS	MONTHLY RATION *cwts.*
Over 1 and not over 5	4 (including not more than 1 sow)	2
,, 5 ,, ,, ,, 20	8 (,, ,, ,, ,, 2 sows)	4
,, 20 ,, ,, ,, 50	12 (,, ,, ,, ,, 2 ,,)	6
,, 50 ,, ,, ,, 150	24 (,, ,, ,, ,, 4 ,,)	12
,, 150 ,, ,, ,, 300	48 (,, ,, ,, ,, 6 ,,)	24
,, 300	72 (,, ,, ,, ,, 8 ,,)	36

Up to 5 acres there is no change, but over 5 acres the numbers of pigs for which half rations can be obtained is considerably increased. A number of pig-keepers receiving basic rations will therefore benefit by transferring to the extended scheme. In England, anyone in doubt on this point should ask the County Committee for advice on the advantages or otherwise of such a transfer, and all intending entrants to the extended scheme should apply to their Committee as soon as possible. In Scotland, queries and application forms should be sent to the Department of Agriculture for Scotland, Government Buildings, Bankhead Avenue, Sighthill, Edinburgh, 11.

Cleaning Combine-Harvested Grain The wise organization of combine harvesting requires that cutting shall be delayed until the crop is fully ripe. It also calls for cutting the crop only in the driest part of the day. These two factors usually mean that when the combine is at work it must be operated at as high a cutting rate as possible, which in turn may lead to something less than a perfectly clean sample.

In some seasons it has been possible to sell even dirty grain straight from the combine. But this is becoming more difficult; grain with too much chaff and broken seeds and rubbish in it may not find a good market in future. Moreover, the increase in the number of combine harvesters throughout the country has intensified the need for storing grain, if only for a short period, in the farm buildings. Any greenstuff left in the grain increases storage difficulties.

Grain drying plants have cleaners incorporated in their mechanism. Some driers have both a pre-cleaner and a final dresser. The pre-cleaner, which often consists of a simple winnower with a sieve to separate coarse rubbish, removes material that might injure the drier, interfere with the passage of air through the grain, or taint the grain during drying. The final dresser has a set of riddles, rotary screens or indented cylinders, to clean and grade the grain. Therefore, if the grain is dried, the cleaning is looked after automatically.

The aim nowadays, however, is to plan the combining so that as little as possible of the crop needs to be dried at all. Nevertheless it is often a good thing to run the drying mechanism without the heating apparatus, so that, even when tests have shown that the moisture content is low enough to make artificial drying unnecessary, the grain can pass through the machine. This not only cleans the grain but also evens out the moisture content, by dispersing any small damp patches into the bulk of the grain.

Many farmers have no drier at all on the premises, and rely in an emergency on communal drying facilities, but it is well worth while in these cases to fix up some simple cleaning apparatus. Many farmers will have one of the old wooden winnowing and dressing machines that were used thirty years ago. Many of these machines, which combined winnowing, riddling and screening, were hand-turned, and their rated capacity was about 40 bushels an hour. In thinking of capacities, however, it must be remembered that the output varies considerably with the state of the grain passing through it. Unusually dirty grain may have to go through the machine at only half of the rated throughput speed. Nevertheless these old hand-turned machines can be relied on to clean half a ton of grain in an hour. Hand-turning hour after hour is an irksome job, and it is well worth while to rig up a small engine to drive the machine. Larger machines were made and these can sometimes be bought secondhand. They need a 2 or 3 h.p. engine and they are rated at 100 bushels an hour.

Cleaners of this kind are still made by several manufacturers, and, in addition, several new kinds of machines are now available. These range from miniature winnowing and sieving machines for dealing with 10 bushels of wheat an hour, up to cleaning and grading machines dealing with 4 tons of wheat an hour.

It is well to fit it up in the barn in such a way that handling of the grain before and after cleaning will be as easy as possible. For example, it may be possible to construct some kind of receiving hopper and elevator to deliver the grain into the winnowing machine, and to site the machine so that the sacking-off spouts are conveniently placed. It is often a good plan to have the weighing machine sunk into the floor, so that the platform is at ground level. If fitting up involves the use of chutes it should be remembered that they should be wider at the bottom than at the top, and any bends in them should be arranged in such a way as not to present corners where grain may pile up and cause a blockage.

One other way of cleaning grain should be mentioned. If an ordinary stationary threshing machine is available on the farm, the combined grain can be passed through it to take advantage of the cleaning and grading mechanism.

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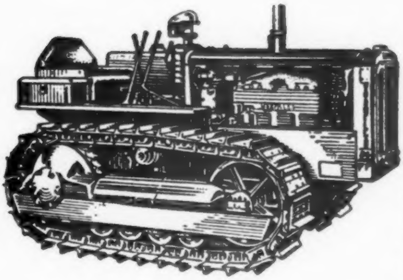

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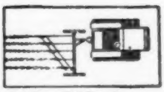

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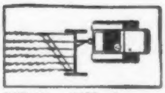

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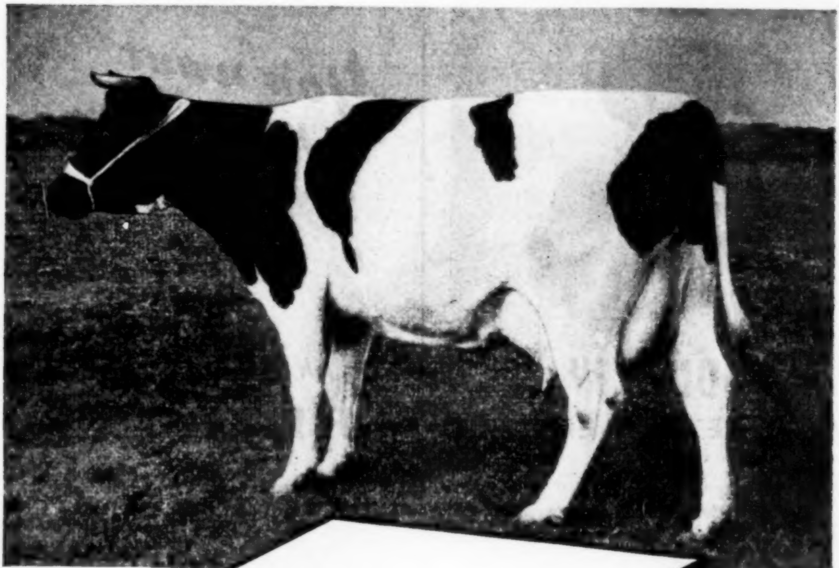

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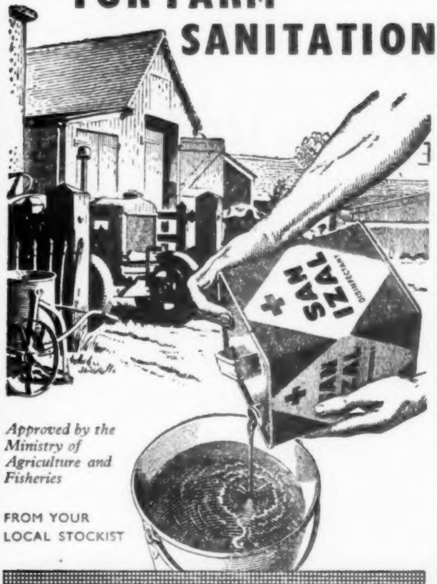
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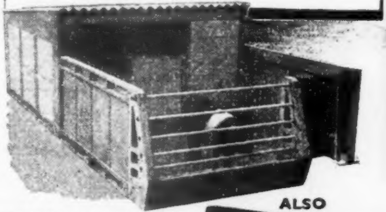

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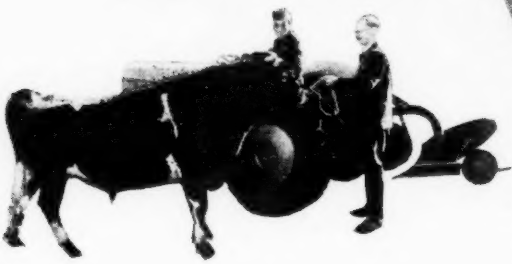
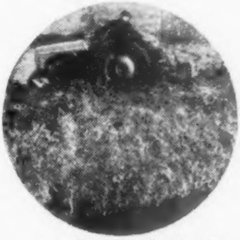




Bob Hawling uses the Ferguson earth scoop to shift soil from an irrigation ditch.

A Ferguson tractor turns a Somerset wilderness into land fit to support a pedigree herd of Guernseys

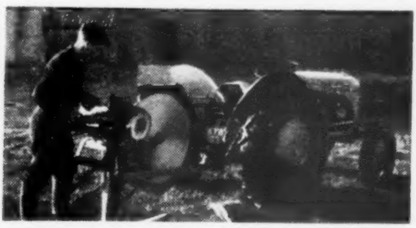
"The soil may be peat, but it floats on water," farmers warned Dr. William Plant when, two years ago, he bought Tickenham Court Farm, Clevedon, Somerset, and 110 acres of unpromising marginal land. Nevertheless, Dr. Plant announced his intention of establishing a pedigree herd of Guernseys and supporting them on this land that flooded for six to eight months every year.

Much of the land was deep peat soil on blue clay sub-soil, but without the usual acidity of peat thanks to the run-off from surrounding limestone ranges. It had the promise of richness, but could that richness be brought to light? Dr. Plant thought it could. He bought a Ferguson tractor (£325), a mower (£75), a 16" plough (£28) and an earth scoop (£12.10s.).

"The land simply was not negotiable except with a Ferguson," the Doctor tells us now. "And only a Ferguson with its mower could be used to cut the rushes successfully. They have to be cut three times a year and an ordinary trailer mower could not start early enough."

The rushes were cut, the rich soil was ploughed and arable crops were planted. Beans, linseed and oats thrived and rich, high-protein grass was provided for the yearlings which were imported from Guernsey as the nucleus of the herd in 1946. The first five heifers lactation was 840 gallons in 305 days and butterfat content of the milk was 4.7 per cent. The "floating farmland" had become a good deal more than self-supporting.

The deep-digger 16" Ferguson plough goes to work on land which two years ago farmers declared unworkable—until they saw it being worked by the Ferguson.



One Ferguson in its day plays many parts on Dr. Plant's farm. In the courtyard before the 14th century buildings of The Court, Bob Hawling gets to work with the wood saw.

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